ELEMENTS COLLECTOR

ENTER

A digital companion to **The Elements**

SCHOLASTIC discover more™

You might not be the first aspiring scientist to discover Earth's elements, but you can find most of them in everyday objects.
Click a group and start collecting your own 3-D periodic table.

Periodic table complete collection

How to use your digital book!

It's elemental!
Remember, you will rarely collect the elements in their elemental form—but you will find things that contain compounds and alloys of the elements in combination with other chemicals.

Alkali metals

Alkaline earth metals

Transition metals

Poor metals

Metalloids

Nonmetals

Halogens

Noble gases

Lanthanoids

Actinoids

Warning!
A few elements are dangerous or difficult to collect in any form. Watch out for these signs and find a photo to collect instead.

Hydrogen [The loner]

1
H

Hydrogen is a tasteless, colorless, and odorless gas that is the most abundant substance in the Universe. You will find hydrogen in water and in all living things, and it has countless uses, from making food to launching rockets into space—the huge orange tanks attached to space shuttles at launch are filled with liquid hydrogen. Hydrogen is most widely used in oil refining to make gasoline and is an essential ingredient in chemical compounds used for making paints, varnishes, and plastics. It is also used to harden metals and give them shinier surfaces.

In food processing, hydrogen is combined with oils—in a process called hydrogenation—to create margarine, shortening (used to make pastry crumbly), and other solid fats.

Bagels contain hydrogen in the form of **carbohydrates**, which are molecules composed of carbon, hydrogen, and oxygen. Carbohydrates provide energy for the body.

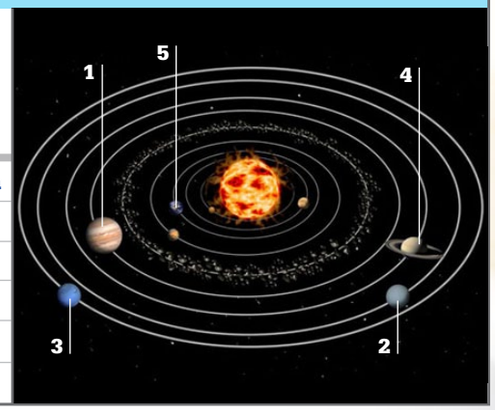
Margarine and other spreads sometimes contain hydrogenated vegetable oils, made by forcing hydrogen gas into oil at high pressure and high temperature.

Periodic table complete collection

Hydrogen and the planets

Planets are surrounded by a layer of gases known as an atmosphere. Earth's is mainly nitrogen (78.09%) and oxygen (20.95%), with small amounts of other gases. The larger outer planets have atmospheres of mostly hydrogen, with helium and traces of other gases.

Planet	% of atmosphere that is hydrogen
1 *Jupiter*	*90% (+ 10% helium, traces of others)*
2 *Uranus*	*82–84% (+ 15% helium + 2% methane)*
3 *Neptune*	*80% (+ 19% helium+methane)*
4 *Saturn*	*75% (+ 24% helium+methane)*
5 *Earth*	*Traces*



Collect more hydrogen

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Bagels contain hydrogen in

Hydrogen fuel-cell car (from Honda, in Japan)

Hydrogen

Hydrogen is not found in its natural, uncombined state on Earth. Although some pure hydrogen is released by natural gas wells, coal deposits, and organic decay, it reacts with the components of the air and other substances so completely that none of the free element is left. In a combined state, hydrogen is most commonly found in compounds with oxygen, carbon, and nitrogen. For instance, ammonia is formed from a compound of nitrogen and hydrogen and used to create plant food and household cleaners, among other things. Every water molecule has one oxygen atom attached to two hydrogen atoms. Hydrocarbons—chemical compounds of hydrogen and carbon—are used to make plastics to create bottles, yogurt containers, balls, and many more things that we use daily.

Scientists are experimenting with ways to use hydrogen as a fuel. It burns like natural gas but does not pollute like the fossil fuels (coal, oil, and gas) do. Carmakers have developed vehicles that use hydrogen as their fuel instead of gas or diesel, with hydrogen fuel cells providing power for electric motors. A fuel cell converts hydrogen and oxygen into water, also producing electricity in the process. Even hydrogen-powered cell phones have been made, though none of the above are widely available.

Collect more hydrogen

More hydrogen things to collect

You'll find hydrogen compounds in many things around the home. The most common compound of hydrogen is water, and it is an essential ingredient of soaps, food, and the miniature plastic figures you may collect! Plastic is a mix of hydrocarbons (compounds containing hydrogen and carbon). Hydrogen peroxide is usually present in minuscule quantities in raindrops, and it is also used commercially in hair-lightening shampoos, teeth-whitening toothpastes, and cleaning supplies.

HOME

AMAZING ELEMENTS

Our galaxy
There are more than 200 billion stars in our galaxy, each composed of hydrogen and helium. In between them are clouds of swirling gas, made up mainly of hydrogen.

1
H

Periodic table complete collection

Cookie

Some of the cookies you buy at a grocery store contain partially or fully hydrogenated oils. Check the label. Add them to your collection but not to your stomach, since eating a lot of hydrogenated oils is bad for you!

Glass of water

Water is the most common hydrogen compound. Water molecules are made up of one oxygen atom and two hydrogen atoms.

Cleansing cream

Hydrogen compounds are part of many face creams and are used in the process of making essential oils and fragrances.

Plastic cup

Plastic is created from hydrocarbons, which are molecules (particles) made from hydrogen and carbon atoms. The raw materials from which most plastics are made come from petroleum.

Soap

Hydrogen is combined with mixtures of sodium or potassium salts, plus grease derived from oils or fats, to create soap.

Corn oil

Oils and fats are lipids (fatty substances found in all living organisms) and are made from hydrogen, oxygen, and carbon.

Raindrop

Raindrops can pick up sulfur and nitrogen compounds in the air to make acids, which contain hydrogen. This process results in acid rain, a type of pollution that can poison plants and animals.

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Bagels contain hydrogen in

Launch of space shuttle Discovery *in 2009*

Hydrogen rocket

Liquid hydrogen is used as fuel to power many rockets and space vehicles, including the space shuttles NASA used between 1981 and 2011. In its simplest form, a rocket is a tube of fuel, closed at one end and open at the other. As the fuel burns, it creates hot gases that expand and emerge rapidly from the open end. The action of the rushing gases causes the rocket to move in the opposite direction. This push is called thrust. The faster the gases rush out, the faster the rocket moves.

Rocket propellants may be either liquid or solid. Hydrogen and oxygen are used to power the biggest space rockets because they provide more energy per ton than any other fuel. Even so, massive amounts are needed. For example, the main engines of a space shuttle like *Discovery* burn liquid hydrogen, and each of its two solid rocket boosters carries more than 500 tons of solid propellant. For enough fuel to be carried, the gases have to be liquefied and kept very cold until needed. To change hydrogen gas into a liquid form for fuel means cooling it to –423°F (–253°C).

A space shuttle's large external tank is loaded with supercold liquid oxygen and liquid hydrogen, which are mixed together and burned to create the fuel for the shuttle's three main rocket engines.

As a shuttle accelerates, the main engines burn

500,000

gallons (1,890,000 L) of liquid hydrogen

Collect more hydrogen

Hydrogen [The loner]

HOME

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Bagels contain hydrogen in |

carbohydrate *noun*

Carbohydrates are compounds, such as sugar and starch, that are composed of carbon, hydrogen, and oxygen. They are the most abundant single class of organic substances found in nature. They have many essential functions in all organisms, and they serve as a major source of food for humans and animals.

Green plants produce carbohydrates through a biological process called photosynthesis. In this process, energy from sunlight is used to form organic compounds and to release oxygen from carbon dioxide and water.

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Planet	
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3 2

sometimes contain hydrogenated vegetable oils, made by forcing hydrogen gas into oil at high pressure and high temperature.

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hydrogenation *noun*

Hydrogenation is a process that changes liquid vegetable oils to solid or semisolid form by adding hydrogen atoms under pressure at high temperatures. *Partially hydrogenated* means that the end product is semisolid, with a consistency a bit like butter's.

Hydrogenated and partially hydrogenated oils are common in some margarines, and they are the predominant fats used in many commercially baked goods (such as cookies, crackers, and chips). They are also used in soaps, lubricants (greases), and some skin-care products to create a creamy consistency.

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Collect more hydrogen

Potassium [Alkali metals]

HOME

19
K

Potassium in its natural state has relatively few uses. The metal is extremely reactive, and sodium, another alkali metal, has similar properties and is less expensive to use. Potassium compounds, however, do have important uses. In particular, millions of tons of them are used annually as fertilizers to help food and plants grow.

For humans, potassium is an essential mineral for maintaining the proper function of all cells, tissues, and organs in the body. It is also an electrolyte, a substance that conducts electricity in the body, as are sodium, chloride, calcium, and magnesium.

Top food sources of potassium

Many foods are good natural sources of potassium, but these top the charts! Often, drying or cooking the food increases the amount of potassium in it, as in dried grapes (raisins) and baked potatoes.

1	*Papaya (one fruit)*	*781 mg*
2	*Baked potato (one potato)*	*694 mg*
3	*Beets (half a cup / 85 g)*	*655 mg*
4	*Raisins (half a cup / 120 g)*	*598 mg*
5	*Dates (half a cup / 120 g)*	*584 mg*

Periodic table complete collection

A medium-size banana contains 422 mg of potassium. The recommended daily intake for an 8- to 13-year-old is 4,500 mg.

Banana skins added to compost heaps put **nutrients** back in the soil—including potassium, which is important for keeping plants healthy.

More potassium things to collect

Potassium nitrate was first used for fireworks

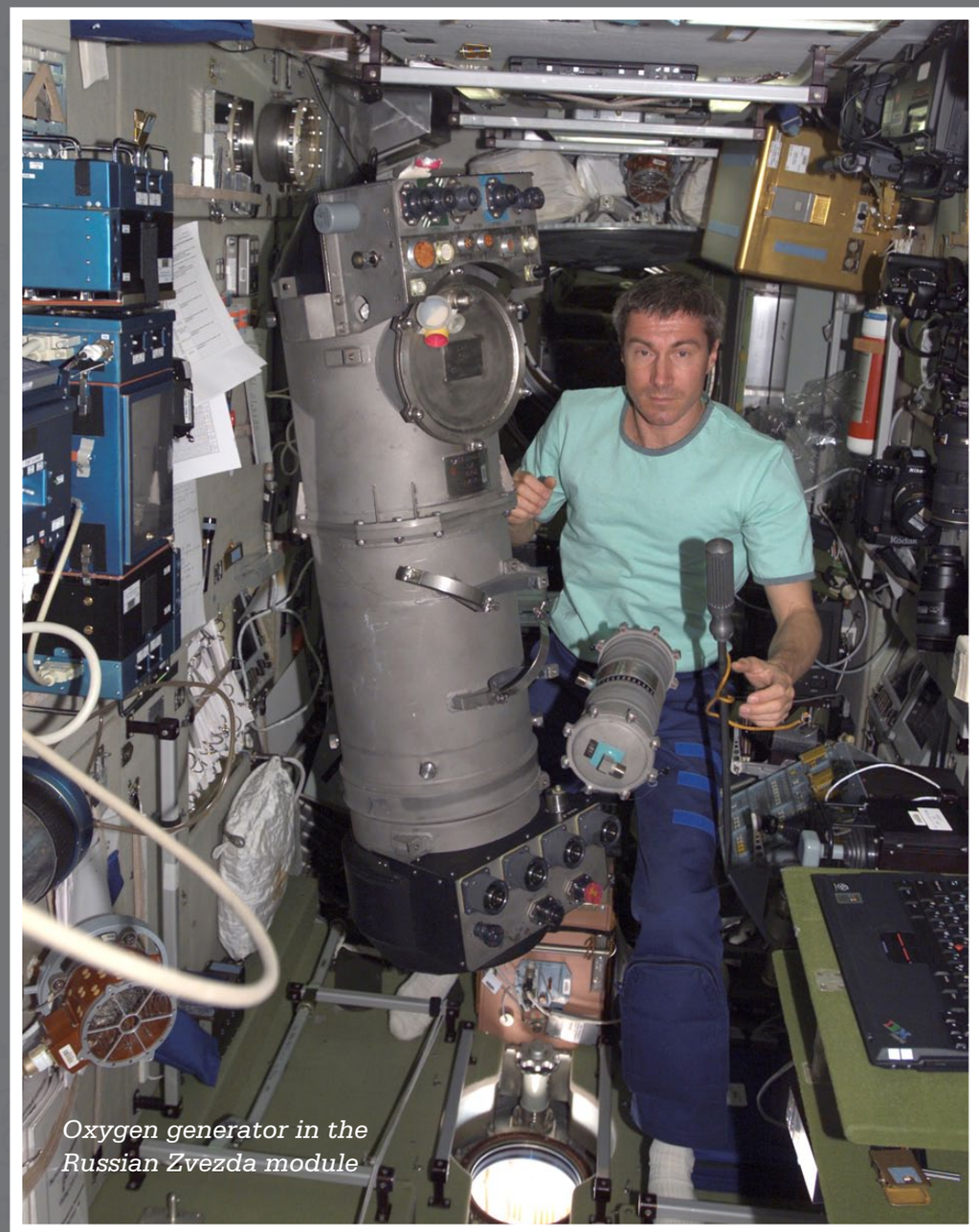
in 600–900 CE

in China—it is still used today

Collect more alkali metals

Potassium [Alkali metals]

19
K



Oxygen generator in the Russian Zvezda module

Potassium

The name *potassium* comes from the word *potash*, or "pot ashes." Compounds of potassium—as well as other alkali metals—were obtained from wood ashes as far back as ancient Roman times. These were used to make glass, soap, and other products. Creation of potassium carbonate became a major industry over the years, but this caused severe depletion of woodlands, since ashes from several acres of timberland were needed to produce just 1 ton of crude potassium carbonate. After the production of cheap sodium carbonate from limestone and salt began in the 19th century, many countries were able to slow the destruction of their forests.

In medieval China, around the 9th century CE, potassium nitrate (a compound of potassium and nitrogen) was used to invent gunpowder. In recent years, the chemical compound potassium superoxide has been used in breathing equipment, such as masks for firefighters and mine rescuers. It refreshes exhaled air by providing oxygen and absorbing carbon dioxide. The Russian Federal Space Agency has used potassium superoxide in oxygen generators for its space suits, its *Soyuz* spacecraft, and the Zvezda service module on the International Space Station (ISS). It has also been used in the air supply of submarines and aircraft.

Potassium was discovered and isolated in

1807

by English chemist Humphry Davy

More potassium things to collect

Soap making, glass making, and other manufacturing processes make use of potassium compounds, especially potassium carbonate (potassium with carbon and oxygen). Other potassium compounds are used in dyes and stains, and as the reacting agent in some invisible inks. The rarer potassium superoxide ion is used in high-tech breathing equipment, such as masks for firefighters and space suit life-support systems.

HOME

Periodic table complete collection

Collect more alkali metals

AMAZING ELEMENTS

Mauve fireworks
Potassium compounds, and those containing another alkali metal, rubidium, are sometimes used in fireworks to give them a purple color.

19
K

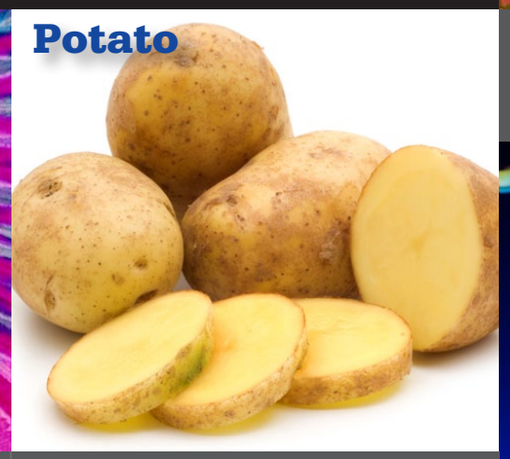
Plants and soil

Potassium is found in all living cells. As potassium chloride, it is found in most soils, and gardeners often add potassium to plants via an organic fertilizer called potash.

Dye

Potassium compounds and sodium carbonate are widely used as dye fixers. A fixer causes the chemical reaction that makes a dye become part of the fabric rather than just washing off.

Potato



Although their names sound similar, potatoes are not named after the element. Potatoes do contain high amounts of potassium.

Soap

Potassium and sodium are both used in soap manufacturing, commercially and for homemade soaps. They dissolve in water and are effective cleaning agents.

AMAZING ELEMENTS

Firefighter's mask
Potassium superoxide reacts with carbon dioxide to release oxygen, so it is used as an oxygen source for firefighters, in mine rescue, and in some space suits.

19
K

White bean

Half a cup (227 g) of white beans—the sort you would eat in stews or baked beans—contains 595 mg of potassium. Dried beans are easier to add to your collection and will last longer than cooked food.

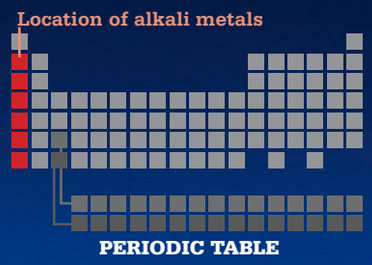
Colored ink

Potassium chromate is sometimes used in inks, dyes, stains, and in ink-jet computer printers.

Orange juice

Citrus juices, including orange, are good sources of potassium. One cup (240 mL) can replace the potassium lost during one to two hours of hard exercise.

Alkali metals [Reactive]



The six alkali metals are soft—not the type of metal you would use to build with. They range from sodium, which occurs mainly as sodium chloride (salt) and makes up about 80 percent of the material dissolved in seawater, to francium, rarely seen outside of a science lab. Lithium is used in batteries that can store more energy in smaller, lighter sizes, ideal for electronic devices. Rubidium has medical applications, including heart muscle research, and cesium is included in radio equipment used in construction industries.

3 Li Lithium

iPod battery
Lithium-ion batteries are very popular. These rechargeable batteries are found in laptops, cell phones, and iPods.

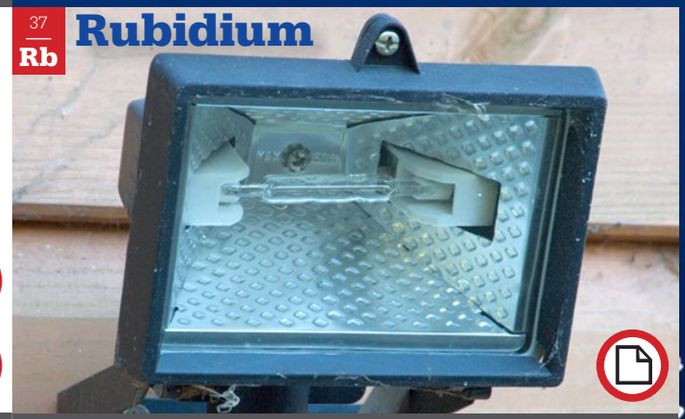
11 Na Sodium

Baking soda
Sodium bicarbonate—known as baking soda, bread soda, cooking soda, or bicarbonate of soda—is used in cooking.

87 Fr Francium

Experiments
Rare and volatile, dangerous francium has few uses, except in nuclear industries and science experiments.

37 Rb Rubidium



Motion detector
Rubidium is used in the manufacture of photocells, which convert light energy from the Sun into electrical energy. It is also used in motion detectors for security alarms.

Periodic table complete collection

AMAZING ELEMENTS

Atomic clock 55 Cs
The most reliable and accurate clocks are atomic clocks that include cesium. This one, in Boulder, Colorado, varies by 1 second in 370,000 years.

11 Na Sodium

Table salt
Common table salt is sodium chloride, composed of the elements sodium and chlorine.

Alkali metals [Reactive]

Location of alkali metals

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Salt extraction at La Palma, Canary Islands, Spain

Sodium chloride

Sodium chloride, or common salt, is the chemical compound NaCl, which is composed of the elements sodium and chlorine. Salt occurs mainly in seawater, which contains an average of 120 million tons of sodium chloride per cubic mile (26 million t per cu. km.).

Extensive salt deposits also occur on land, mainly underground—sodium makes up about 2.8 percent of the Earth's crust. In some parts of the world, it appears on the surface in enormous **salt flats**, most spectacularly in Bolivia and North America. Salt flats formed from ancient seas that dried up and left behind salt and other sodium mineral deposits. Salt that is mined from solid layers in the ground is called rock salt.

Salt has been a valuable trade item and preservative throughout human history—the English word for an employee's monthly payment, *salary*, is derived from *salarium*, the Latin word for the money given to Roman soldiers for purchasing salt. Today it is produced commercially by rock salt mining, by solar evaporation (using the Sun's heat to evaporate water from oceans or lakes, leaving behind the salt), or by solution mining, in which water is pumped into an underground salt deposit, then piped to the surface.

Doctors recommend no more than

2,300 mg

of salt per day—less than a teaspoon!

3 Li Lithi

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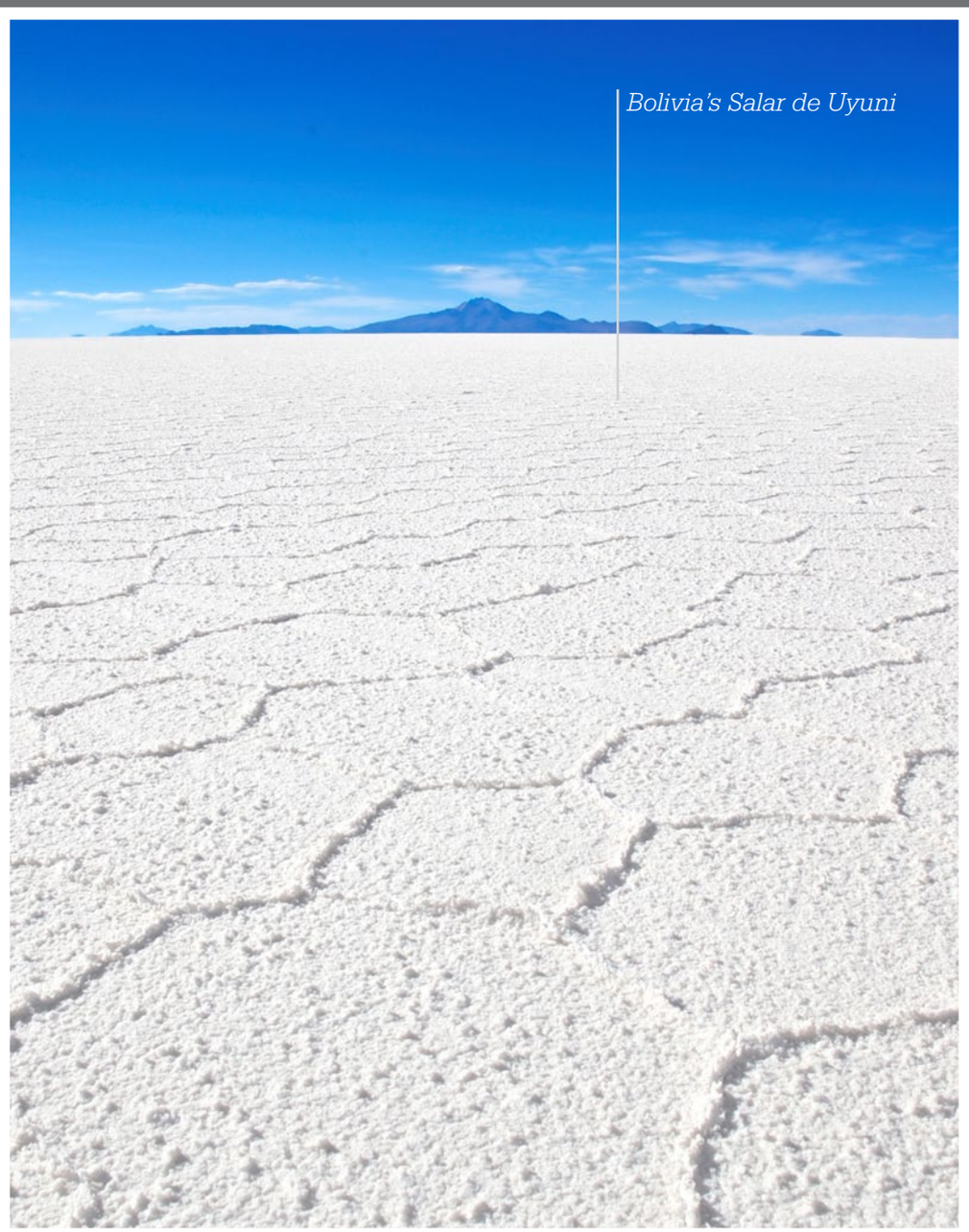

Bolivia's Salar de Uyuni

Salt flat

The incredible Salar de Uyuni (Uyuni Salt Flat) in Bolivia, South America, is a huge white plain with a surface formed by grains of salt. Some 30,000 to 42,000 years ago, the area was part of a giant prehistoric lake, Lake Minchin. When the lake's level dropped and the waters receded, evaporation left large concentrations of dissolved minerals deposited in the surrounding soil. Underneath the solid salt-crust surface of the flat is a lake about 7 to 66 feet (2 to 20 m) deep.

Around 28,000 tons of salt are extracted annually from the Salar de Uyuni for use in the chemical and food industries, only a fraction of the 11 billion tons it is estimated to hold. Uyuni is roughly 25 times the size of the Bonneville Salt Flats in the United States.

The Bonneville Salt Flats in Utah are 46 square miles (119 sq. km.) in area and contain about 147 million tons of salt. Like the Salar de Uyuni, Bonneville was formed by a deep, ancient lake that receded, leaving behind its minerals. These minerals include potash, which is used commercially as fertilizer and table salt. Approximately 90 percent of the salt in the Bonneville Salt Flats is common table salt.

The Salar de Uyuni covers

4,086 (10,582 sq. km.) sq. mi.

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Potassium [Alkali metals]

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electrolyte *noun*

Electrolytes are the more important minerals, specifically ions, in the body. They include sodium, potassium, chloride, calcium, magnesium, and phosphorus, and are dissolved in the blood.

When salts such as sodium chloride are dissolved, they break apart into charged particles called ions. Each ion carries either a negative or a positive charge. These charged particles create electricity (like a battery does) that helps run the body.

Collect more alkali metals

More potassium things to collect

HOME

Plants and soil

Soap making, glass making, and other manufacturing processes
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ion *noun*

Ions are electrically charged particles formed when atoms lose or gain electrons. An ion can have a positive or negative charge. It may acquire its charge through the transfer of electrons from one atom to another, as when sodium and chlorine react to form the ionic compound sodium chloride.

Metal atoms and nonmetal atoms tend to act in opposite ways when they ionize. A metal atom loses the electron or electrons in its highest energy level and becomes a positively charged ion. A nonmetal atom tends to gain an electron or electrons from another atom to become a negatively charged ion.

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called potash.

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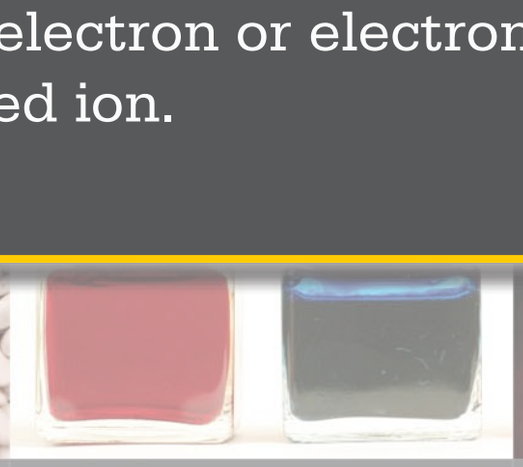
Half a cup (227 g) of white beans—the sort you would eat in stews or baked beans—contains 595 mg of potassium. Dried beans are easier to add to your collection and will last longer than cooked food.



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nutrient *noun*

Nutrients are chemicals that every living creature needs, to build and repair their bodies and supply the energy necessary to survive. These chemicals come from the food we eat.

The nutrients in our food are classified as proteins, carbohydrates, fats, minerals (electrolytes such as potassium, sodium, and calcium, and trace elements such as zinc, copper, and fluoride), vitamins, and fibers. Proteins provide the material necessary to grow and to maintain and repair the body; carbohydrates provide fuel and energy; and fats also provide fuel, plus insulation. Minerals help build teeth and bones; they also, along with vitamins, keep us healthy.

Calcium [Alkaline earth metals]

HOME

20
Ca

The element calcium is a silver metal, but it is rarely found in its natural metallic form. Instead, it is commonly seen in the compound calcium carbonate (calcium, carbon, and oxygen), which forms limestone, coral, seashells, and stalactites and stalagmites—the icicle-like formations in underground caves.

Another compound, calcium phosphate (calcium with oxygen and phosphorus), is the mineral that builds teeth and bones in animals. It is also essential for keeping your heart beating steadily and your blood and nerves functioning.

The teeth and bones hold

90%

of the body's store of calcium

Enamel, the outer coating of a tooth, is composed mainly (96 percent) of a crystalline form of calcium phosphate. The rest is water and organic material.

Under the enamel is dentin, a hard layer that needs a continual supply of calcium to keep it from crumbling.

The roots of teeth have networks of nerves and blood vessels inside. If there is not enough calcium in the diet, the body will draw calcium from teeth and bones to use for other functions.

More calcium things to collect

Periodic table complete collection

Top sources of calcium

Green vegetables, some fish, soybean products, and most dairy foods contain a lot of calcium. These five foods are among the top sources. Children and teens aged 9–18 need the most: 1,300 milligrams a day!

1	*Cheddar cheese (3.52 oz. / 100 g)*	*740 mg of calcium*
2	*Tofu (3.52 oz. / 100 g)*	*510 mg*
3	*Sardines in oil (3.52 oz. / 100 g)*	*500 mg*
4	*Curly kale (3.52 oz. / 100 g)*	*151 mg*
5	*Skim milk (3.38 fl. oz. / 100 mL)*	*122 mg*

Calcium [Alkaline earth metals]

HOME

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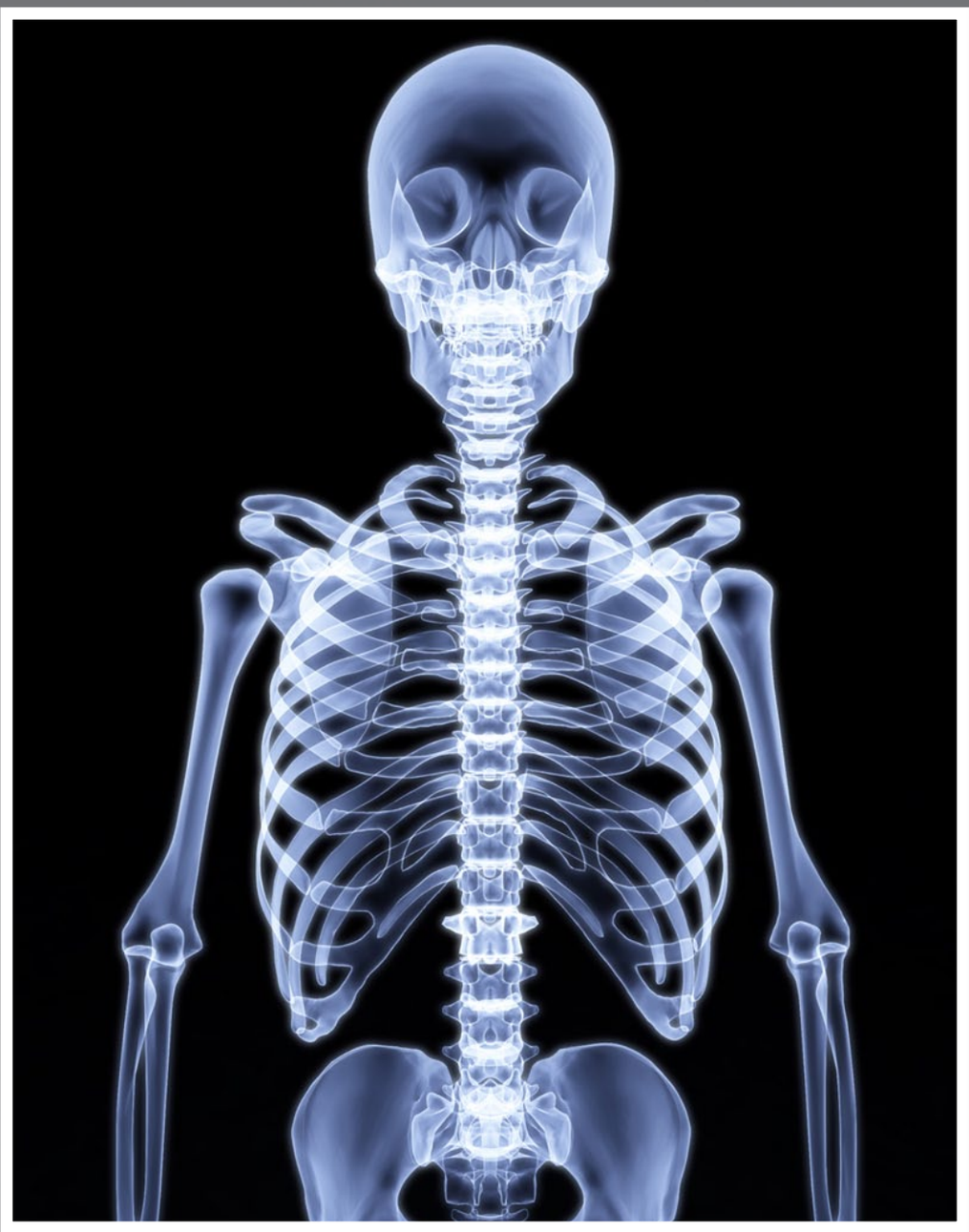


Calcium

Calcium is a chemical element in the family of alkaline earth metals. In its elemental state, calcium looks metallic and is a good electrical conductor. However, calcium is very reactive and easily forms compounds with oxygen and water, so it is rarely found in an uncombined state in nature. It is often found as calcium phosphate, which builds bones and teeth in animals, and calcium silicate, calcium fluoride, and calcium sulfate.

Although calcium metal is silver, calcium compounds occur either as white powder or as colorless crystals. Calcium sulfate is powdery and white but can grow into large, hard, transparent crystals. Huge crystals have grown underground in some places, such as 1,000 feet (304 m) below the Chihuahua Desert in Mexico, where there is a cave system full of them. They were formed from groundwater rich in calcium sulfate, which began seeping through the cave system millions of years ago and was heated by magma from below.

Calcium carbonate is a common white compound that is the primary component of limestone and makes up many rocks. It also builds shell and coral. A pearl consists of layers of calcium carbonate deposited on a piece of sand or dirt that gets inside an oyster. Compounds of calcium and magnesium are also found in hard freshwater.

A fraction of oysters, roughly

1 in 10,000,

grow pearls during their lifespans

Top sc
Green veg
most dairy
foods are
aged 9–18

1 *Cheddar*
2 *Tofu (3.5*
3 *Sardines*
4 *Curly ka*
5 *Skim mil*

Collect more alkaline earth metals

More calcium things to collect

Calcium compounds are more important than those of other members of the alkaline earth family. They are usually white and powdery and have many uses, from medicine to cheese to toothpaste. Marble, chalk, and eggshells are all forms of calcium carbonate, as are pearls, onyx, and coral. Calcium carbonate is also found in limestone, which is used in water purification, sugar refining, and glass, cement, and paper manufacturing.

Collect more alkaline earth metals

Periodic table complete collection

Toothpaste

Calcium compounds are used in many toothpastes as abrasives, to rub or grind dirt off the surface of the teeth.

Chalk

Blackboard chalk is a form of calcium carbonate mixed with a claylike binder. Chalk deposits are found naturally in the soil—the white cliffs on the southern coast of England are made of chalk.

Milk

Skim milk has more calcium than whole milk does (244 mg per 6.8 oz. / 200 mL glass in skim, 236 in whole). Many soy milks have 178 mg.

Plaster cast

Water mixed with a compound of calcium hardens into a plaster, traditionally used to hold broken bones in place while they set.

Fish bone

Fish store calcium in their bones. That's why sardines and Japanese fish cakes are good sources of calcium—the whole fish is eaten.

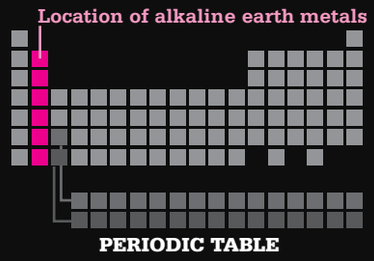
Flashlight

Chemical compounds of calcium are used to create carbide lamps and flashlights, often used by miners and cavers.

Marble mortar and pestle

Marble, formed from calcium carbonate, gets its colors from other minerals in the rock—iron oxide produces the red tinge here. You might see marble in your home as tiles, countertops, or decorations.

Alkaline earth metals



Beryllium, magnesium, calcium, strontium, barium, and radium are the six alkaline earth metals. While magnesium and calcium are abundant in the Earth's crust, the others are relatively rare. Magnesium is used to create metal alloys found in many everyday things. It is strong, light, and the third-most commonly used metal, after iron and aluminum. Magnesium is found in laptops, older cell phones, and parts of cars, bicycles, and aircraft.

Periodic table complete collection

4 Be **Beryllium**

Video-game system
Beryllium alloys are used as electrical conductors in circuit boards in some home appliances, including video games.

56 Ba **Barium**

Credit card
Magnetic strips on credit cards are composed of tiny magnetic particles often made with a compound of barium.

38 Sr **Strontium**

TV screen
Strontium is used in the glass of cathode ray tubes, found in older color television sets, to prevent X-rays from leaking out.

12 Mg **Magnesium**

Pencil sharpener
Magnesium combined with other metals is an alternative to aluminum for metal items such as this pencil sharpener.

12 Mg **Magnesium**

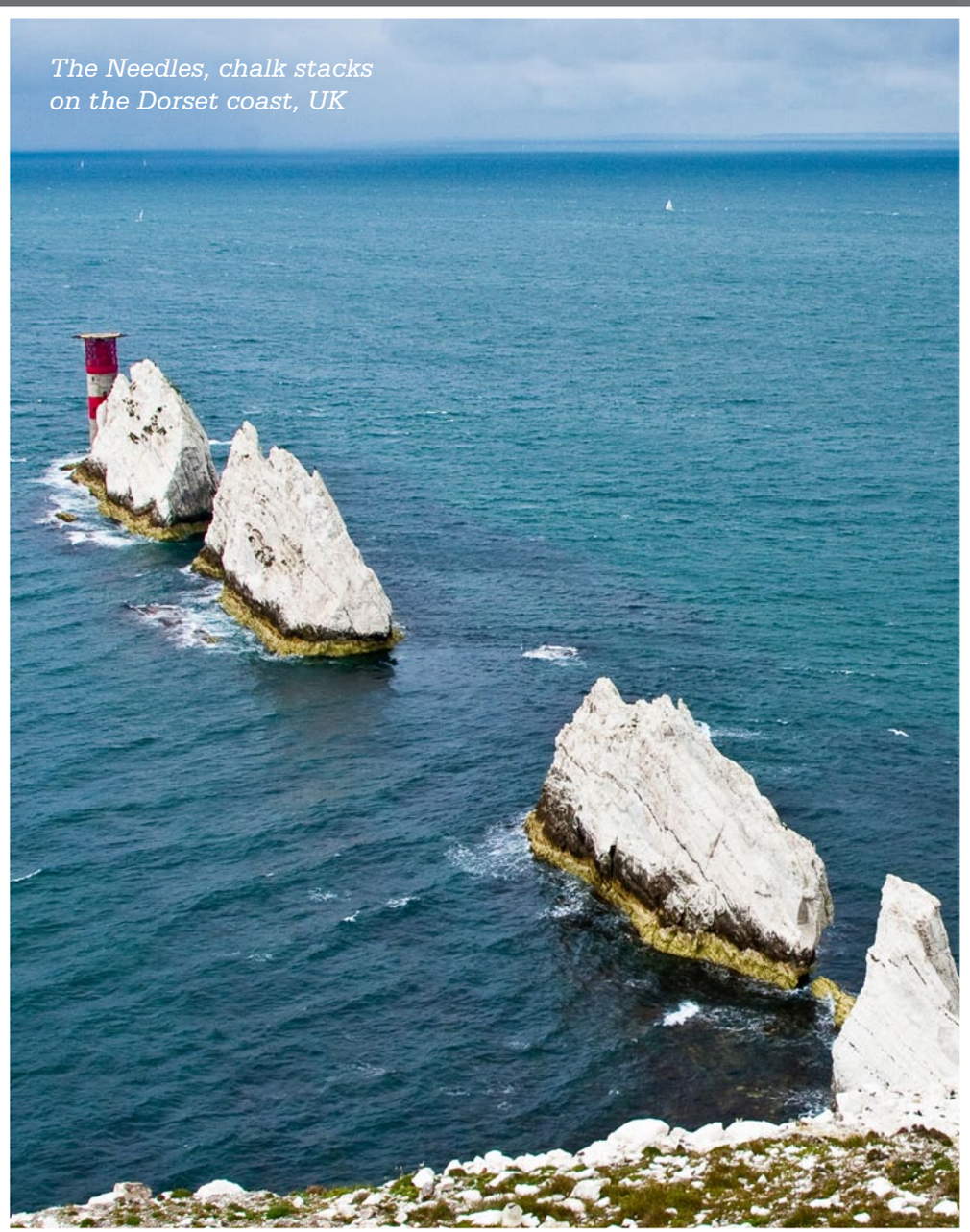
Wheel
Magnesium alloys create sheets of lightweight metal that weighs about 35 percent less than aluminum. This alloy is often used to make strong, light wheels on racing bikes.

AMAZING ELEMENTS

Body scanner
Radium is used in hospital equipment designed to take 3-D scans of the body to diagnose and monitor a number of different health conditions.

88 Ra

More calcium things to collect



The Needles, chalk stacks on the Dorset coast, UK

Chalk

Chalk is a variety of fine-grained limestone, a rock made of calcium carbonate. Chalk is porous, soft, and composed of minuscule fossil fragments of organisms including shellfish, along with crystals of calcite (a mineral derived from calcium).

Chalk is built up over many years. As marine organisms die, their shells settle on the bottom of shallow to moderately deep seas, forming a thick layer. The shells are covered with mud, sand, and other materials and are squeezed together by the heavy pressure of the water above them. This compression forms chalk deposits. The fragments of shell and marine organisms are made of calcium carbonate, which—combined with calcite—makes up 50 percent of chalk. Other minerals in chalk include quartz, various types of clay, and iron oxides.

Many chalk deposits were formed during the Cretaceous period, 136 to 70 million years ago; in fact, *Cretaceous* comes from the Latin word for chalk, *creta*. Famous chalk deposits include the white cliffs of Dover in England and the fossil beds in western Kansas, in which preserved skeletons of extinct animals have been found.

Chalk is used to make rubber goods, paint, putty, and polishing powders, and it is a main ingredient of cement. It can also be used as a soil conditioner.

Blackboard chalk is a form of calcium carbonate mixed with a claylike binder. Chalk deposits are found naturally in the soil—the white cliffs on the southern coast of England are made of chalk.

Fish store calcium in their bones. That's why sardines and Japanese fish cakes are good sources of calcium—the whole fish is eaten.

Chemical compounds of calcium are used to create carbide lamps and flashlights, often used by miners and cavers.

Marble, formed from calcium carbonate, gets its colors from other minerals in the rock—iron oxide produces the red tinge here. You might see marble in your home as tiles, countertops, or decorations.

Calcium [Alkaline earth metals]

20
Ca

The element calcium is a silver metal, but it is rarely found in its natural form. Instead it is commonly

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Stalactites and stalagmites

Stalactites and stalagmites are mineral formations found in limestone caves. Stalactites are the icicle-like shapes that hang from a cave roof, while stalagmites rise up from a cave floor. They sometimes join together, producing pillars.

Stalactites, stalagmites, and similar formations such as sheets, curtains, and crusts are collectively called dripstones, because they are formed by the trickling of groundwater through caves. Groundwater seeps into a cave through the surrounding limestone. The groundwater contains dissolved limestone in the form of calcium bicarbonate. When a droplet of the water is exposed to cave air, the bicarbonate changes into the insoluble calcium carbonate mineral called calcite. Some of the calcite is deposited on the roof, and some is deposited on the floor when the droplet falls. Droplets continue to build on previous calcite deposits, slowly forming stalactites and stalagmites or other dripstone formations.

The fantastic shapes that result may represent tens of thousands of years of groundwater action; the rate and kinds of formations depend on conditions in the cave.

The world's tallest stalagmite, in the Martin Infierno cave, Cuba, is

204 feet (62.2 m)

Top sc

Green veg
most dairy
foods are a
aged 9–18

1 Cheddar
2 Tofu (3.5
3 Sardines
4 Curly ka
5 Skim mil

Calcium [Alkaline earth metals]

HOME

20
Ca

The element calcium is a silver metal, but it is rarely

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crystalline *adjective*

To be crystalline is to be composed of crystals. A crystal is a solid in which the atoms of one or several elements are arranged in a three-dimensional pattern. For instance, an atom of silicon (the second-most common element in the Earth's crust) combines with two atoms of oxygen to form silicon dioxide, a common source of gems such as amethysts. Salt crystals are formed from sodium and chlorine.

Each type of crystal has different properties and shapes. Sugar crystals are oblong and slanted at the ends, while salt crystals are cubic. Almost every rock is made entirely of crystals known as minerals. Every metal object is made of one or more types of tiny crystal, mostly too small to see without a microscope. Even teeth are made of crystals.

Top sc

Green veg
most dairy
foods are
aged 9–18

1	*Cheddar*	
2	*Tofu (3.5*	
3	*Sardines*	
4	*Curly kale (3.52 oz. / 100 g)*	*151 mg*
5	*Skim milk (3.38 fl. oz. / 100 mL)*	*122 mg*

4 5

calcium from teeth and bones to use for other functions.

Collect more alkaline earth metals

Calcium [Alkaline earth metals]

HOME

20
Ca

The element calcium is a silver metal, but it is rarely

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metallic *adjective*

Something metallic contains metal or has the qualities of metal.

Metals are defined by the physical and chemical properties that they share. The most distinguishing property is that they are good conductors of electricity and heat. Another very important characteristic is that most metals can be worked—that is, they will change shape rather than shattering when they are placed under pressure or impact.

Top so

Green veg
most dairy
foods are
aged 9–18

1	*Cheddar cheese (3.52 oz. / 100 g)*	*740 mg of calcium*
2	*Tofu (3.52 oz. / 100 g)*	*510 mg*
3	*Sardines in oil (3.52 oz. / 100 g)*	*500 mg*
4	*Curly kale (3.52 oz. / 100 g)*	*151 mg*
5	*Skim milk (3.38 fl. oz. / 100 mL)*	*122 mg*

The roots of teeth have networks of nerves and blood vessels inside. If there is not enough calcium in the diet, the body will draw calcium from teeth and bones to use for other functions.

Collect more alkaline earth metals

Calcium [Alkaline earth metals]

HOME

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Ca

The element calcium is a silver metal, but it is rarely

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mineral *noun*

A mineral is a solid made up of crystals formed through natural processes. There are about 3,000 different minerals in Earth's crust; small amounts of minerals are also found in foods, such as calcium in milk and iron in apricots.

There are two kinds of mineral. The human body needs macrominerals—such as calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulfur—daily to stay healthy. Microminerals, also called trace minerals, are found in the human body in amounts of less than 5 grams. These include iron, zinc, iodine, chromium, copper, fluoride, manganese, molybdenum, and selenium.

Top sc

Green veg
most dairy
foods are
aged 9–18

1	Cheddar	
2	Tofu (3.5	
3	Sardines in oil (3.52 oz. / 100 g)	500 mg
4	Curly kale (3.52 oz. / 100 g)	151 mg
5	Skim milk (3.38 fl. oz. / 100 mL)	122 mg

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Collect more alkaline earth metals

Iron [Transition metals]

26
Fe

Since ancient Egyptian times, people have been able to extract iron from its ore. Iron is rarely found in its pure form in the earth, and the iron you see around you is almost always alloyed with carbon. Wrought iron is an iron alloy with a very low carbon content. *Wrought* means "worked"—the iron is soft enough to be hammered and twisted into many things, including furniture, fences, and gates. Cast iron, which has a higher carbon content, can be melted and cast (poured into molds) to make kitchen utensils, engines, and pipes.

Iron can be mixed with carbon and other chemicals to make steel, used in everything from cans to the tallest skyscrapers. Steel is not as brittle as cast iron but not as soft as wrought iron, and its carbon content is between cast iron's and wrought iron's.

It is estimated that, worldwide,

2.47 billion tons

of iron ore are mined a year

A cast-iron pan can withstand high temperatures, so it can be used for frying and cooking on a stove. Cast iron holds heat in well, so the pan can also be put inside an oven to cook stews.

Cast-iron cooking pots are much heavier than aluminum ones. An average cast-iron casserole dish weighs around 7 lb. (3.2 kg).

The enameled surface keeps rust (iron oxide) from forming. Iron rusts when it comes in contact with air.

More iron things to collect

Densities of heavy metals

Iron is a heavy metal, but—surprisingly—gold is heavier. Gold is 19 times heavier than water and almost 3 times heavier than iron. Each gold atom weighs almost 4 times as much as each iron atom, which makes gold very dense and heavy.

1	*Gold*	*1,206 lb. per cu. ft. (19,318 kg per cu. m.)*
2	*Mercury*	*846 lb. per cu. ft. (13,552 kg per cu. m.)*
3	*Silver*	*655 lb. per cu. ft. (10,492 kg per cu. m.)*
4	*Copper*	*559 lb. per cu. ft. (8,954 kg per cu. m.)*
5	*Iron*	*491 lb. per cu. ft. (7,865 kg per cu. m.)*

Periodic table complete collection

Collect more transition metals

26
Fe

First cast-iron bridge, at Ironbridge Gorge, Coalbrookdale, England

Iron

Iron is one of the most common elements in the Earth's crust and is found throughout the world in chemical compounds with other elements—most commonly oxygen, carbon, sulfur, and silicon. These combinations form the iron ore that is the most important raw material for making iron and steel. Iron is rarely found in its pure form, except in meteorites. It is the most useful of the metallic elements and has played an important role in the industrialization of our society. The development of the iron industry in the late 18th century was one of the main factors triggering the Industrial Revolution, marking a shift to powered machinery, factories, and mass production.

For many years, iron was an important building material. Its uses ranged from tools to machinery parts to railroads. The world's first cast-iron bridge was built over the River Severn at Coalbrookdale, England, in 1779; it had a far-reaching impact both on bridge design and on the use of cast iron in building for the next century. By the 1890s, however, steel had taken over, following the invention of the Bessemer process. Developed in the 1850s, this process found a way to convert iron to steel in very large commercial quantities. Steel is more flexible and durable than iron and is still the main material used in building today.

98%
of mined iron ore is used to make steel

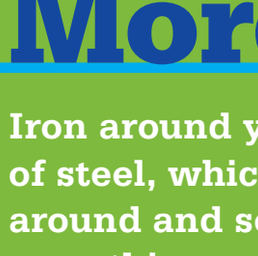
More iron things to collect

Iron around your home and neighborhood is usually in the form of steel, which is stronger and more easily shaped than iron. Look around and see if you can find something made of wrought iron, something cast iron, and something steel. Iron is also an essential mineral found in food. It carries oxygen to all parts of the body. A slight deficiency in iron in the body causes anemia—extreme tiredness and weakness.

Collect more transition metals

Periodic table complete collection

AMAZING ELEMENTS



Building

If you see a building under construction, take a photo of the metal frame. It will probably be steel, an alloy of iron. Steel is the usual choice for building offices and towers.

26
Fe

Chain

The red on this iron chain is iron oxide, or rust. It forms when iron is exposed to oxygen and moisture in the air.

Door knocker

This wrought-iron knocker has a cast-iron lion's head. Door knockers like this are usually coated with beeswax or other wax, which gives them a black color and protects them from rusting.

Dried apricot

There is about 6.3 mg, or 35% RDA (recommended daily allowance), of iron in 20 dried apricots.

Iron nail

Iron nails are usually cut from a flat bar of iron in a factory. Most nails, however, are made of a steel that is mainly iron, 0.1 percent carbon, and traces of manganese or silicon.

Stainless steel container

Stainless steel, used for many kitchen items including kettles and sinks as well as canisters and cutlery, is iron alloyed with carbon and chromium.

Japanese teapot

This decorative cast-iron teapot was cast and finished by hand. The inside is coated with enamel or ceramic.

Chocolate

Chocolate made with pure cocoa powder, without cocoa fat, contains the most iron, about 3.6 mg in 4 oz. (100 g).

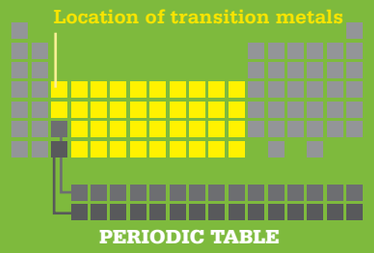
Steel food can

Precooked foods are stored in steel cans with aluminum tabs, since these metals do not rust like tin and iron do.

Cast-iron chair

Molten metal is poured into molds to create the intricate shapes seen on some railings, gates, and furniture.

Transition metals [The shiny team]



Transition metals include the valuable precious metals silver, gold, platinum, and copper, often used in jewelry. These are the only transition metals to occur naturally in a pure form. Other metals from the group are found in a wide variety of minerals and form many compounds. They are used to make everyday objects from coins and pens to cutlery, sunglasses, and instruments. Some are found in food and plants.

Collect even more transition metals

21 Sc Scandium

Metal baseball bat
Much of the scandium used in the United States is in aluminum-alloy baseball bats.

22 Ti Titanium

Titanium golf club
Titanium is a very strong, light metal, unaffected by salty water.

23 V Vanadium

Colored tile
Mixed with zirconium, vanadium makes glazing pigments for tiles and pots.

24 Cr Chromium

Spring
Chromium is often used as a finish over other metals because it doesn't rust.

25 Mn Manganese

Brown rice
Manganese in food helps produce energy from protein and carbohydrates.

27 Co Cobalt

Chinese jar
A compound of cobalt known as cobalt blue is used on painted containers.

28 Ni Nickel

British five-pence piece
In the UK, the newest five-pence coins are pressed from nickel-plated steel.

29 Cu Copper

US penny
A US penny used to be 95% copper, but it is now 97.5% zinc, with copper plating.

30 Zn Zinc

Brass padlock
Zinc is part of many useful alloys, including brass, an alloy of zinc and copper.

39 Y Yttrium

Microwave
Yttrium, along with gadolinium, is used in microwave ovens.

40 Zr Zirconium

Heatproof brick
Zircon sand is used for heat-resistant linings and bricks for furnaces.

41 Nb Niobium

Earring wire
Niobium, a silvery metal, is anodized (put in a chemical bath) to change its color.

42 Mo Molybdenum

Healthy green leaf
This is an essential plant nutrient. Nothing grows if the soil lacks molybdenum.

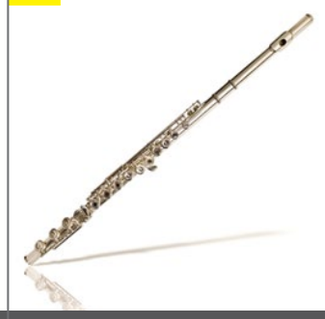
44 Ru Ruthenium

Ski goggles
Ruthenium alloys create mirrored effects on goggles and sunglasses.

45 Rh Rhodium

Mirror
Rhodium is sometimes used as a finish for expensive jewelry and mirrors.

46 Pd Palladium



Flute
Palladium can be made into a thin, goldlike coating often used on instruments.

47 Ag Silver

Silver spoon
Spoons are usually silver plated—with a silver coating over a cheaper metal.

48 Cd Cadmium

Bright paint
Cadmium compounds create bright colors in oil paints.

73 Ta Tantalum

Nut and screw
Tantalum alloys can be used in damp places, including inside human bodies.

More transition metals

Many transition metals are around us in daily life, from gleaming rust-resistant coatings to hidden nuts and bolts that hold things together.

Periodic table complete collection

74 W Tungsten

Tungsten lightbulb
Traditional lightbulbs use tungsten filaments, since they withstand hot temperatures.

75 Re Rhenium

Camera flashbulb
Rhenium compounds are used in some flashbulbs in professional photography.

76 Os Osmium

Ballpoint pen
Osmium alloys can be found in ballpoint and fountain pen tips.

77 Ir Iridium

Sunglasses lens
An iridium coating on sunglasses reduces glare from the Sun.

78 Pt Platinum

Ring
This heavy silver-white metal is used in laboratory instruments and jewelry.

79 Au Gold

Gold watch
An 18K (karat) gold item is 75 percent gold—18 parts gold and 6 parts other metals.

80 Hg Mercury

Thermometer
Mercury thermometers are often used for checking temperatures.

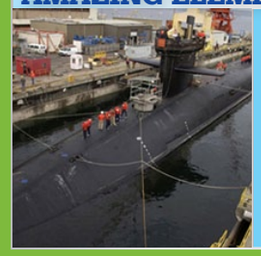
43 Tc Technetium

Star
Scientists analyzing starlight have found technetium in the atmosphere of stars. Closer to home, compounds and alloys containing technetium oxide can be applied to iron to prevent its corrosion in water.

Photographic evidence

Some of the transition metals discovered more recently were created in laboratories by scientists fusing together other elements. Many of these are used mainly in lab experiments, so you will need to collect photographs and facts—not the real things!

AMAZING ELEMENTS



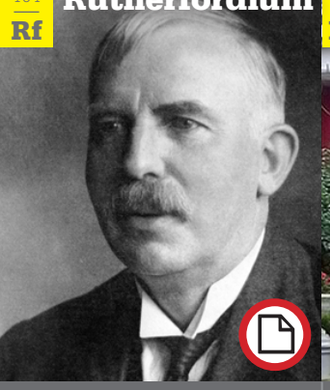
Nuclear submarine
Hafnium gets its name from *Hafnia*, the Latin name for Copenhagen, where it was discovered. It is used in nuclear reactor control rods to absorb neutrons in nuclear submarines.

72 Hf

109 Mt Meitnerium

Lise Meitner
Austrian-born Meitner studied radioactivity. In 1918, she and German chemist Otto Hahn discovered protactinium. Their experiments on **nuclear fission** (splitting atoms) won Hahn the Nobel Prize. Meitnerium was named in Meitner's honor.

104 Rf Rutherfordium

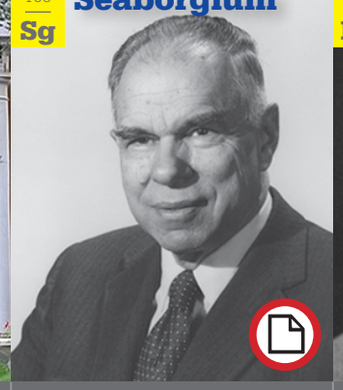


Ernest Rutherford
The 104th element is named after British scientist Ernest Rutherford, known as the father of nuclear physics.

105 Db Dubnium

Dubna, Russia
Dubnium is named for Dubna, Russia, where it was found at the Joint Institute for Nuclear Research.

106 Sg Seaborgium

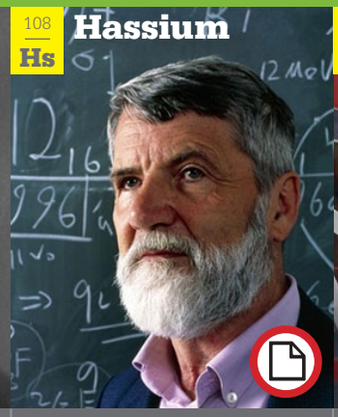


Glenn T. Seaborg
American Glenn T. Seaborg was one of several scientists who discovered this element in Dubna in 1974.

107 Bh Bohrium

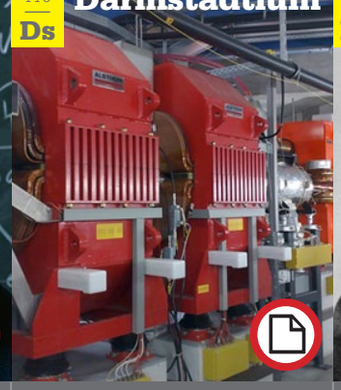
Niels Bohr
Bohrium was synthesized in 1976 by Soviet scientists and named after Danish **physicist** Niels Bohr.

108 Hs Hassium



Peter Armbruster
Armbruster codiscovered hassium, named for the Latin word for Hesse, Germany, where it was found.

110 Ds Darmstadtium



Darmstadt, Germany
This radioactive element is named after Darmstadt, Germany, where it was first created.

111 Rg Roentgenium

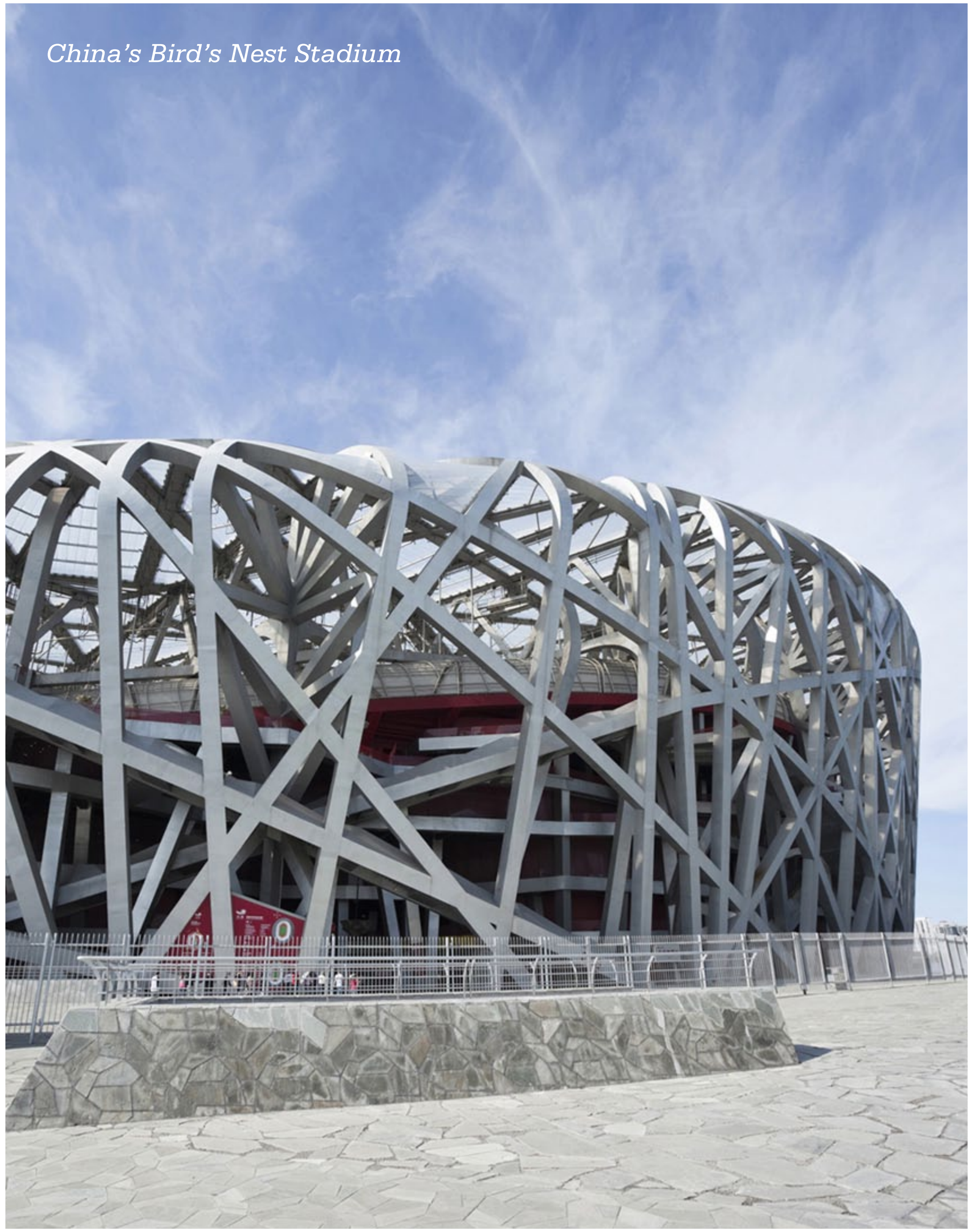
Wilhelm C. Röntgen
Roentgenium was made in Darmstadt in 1994, exactly 100 years after Röntgen discovered X-rays.

112 Cn Copernicium

Nicolaus Copernicus
Isolated in Darmstadt in 1996, copernicium honors the 16th-century Polish astronomer Copernicus.

26
Fe

Steel



China's Bird's Nest Stadium

Steel is an alloy that is created from iron mixed with a small amount of carbon. To make steel, iron ore is heated and smelted (melted) to remove impurities, and carbon is added. Steel is at least 50 percent iron, while the carbon content ranges from 0.03 percent to about 2.25 percent. Other metals are added to give it extra properties such as hardness or toughness. There are three types of steel: carbon steel, low-alloy steel, and high-alloy (stainless) steel.

Carbon steels contain up to 1.65 percent manganese, or small quantities of silicon, aluminum, copper, and other elements, which helps keep the steel from being brittle. Carbon steels, which are cheap, strong, and easily shaped, are used for car bodies, appliances, machinery, ships, and buildings.

Low-alloy steels are 1 to 5 percent other elements, such as nickel, chromium, molybdenum, tungsten, or titanium. Low-alloy steels are used mostly in products like aircraft parts and tools.

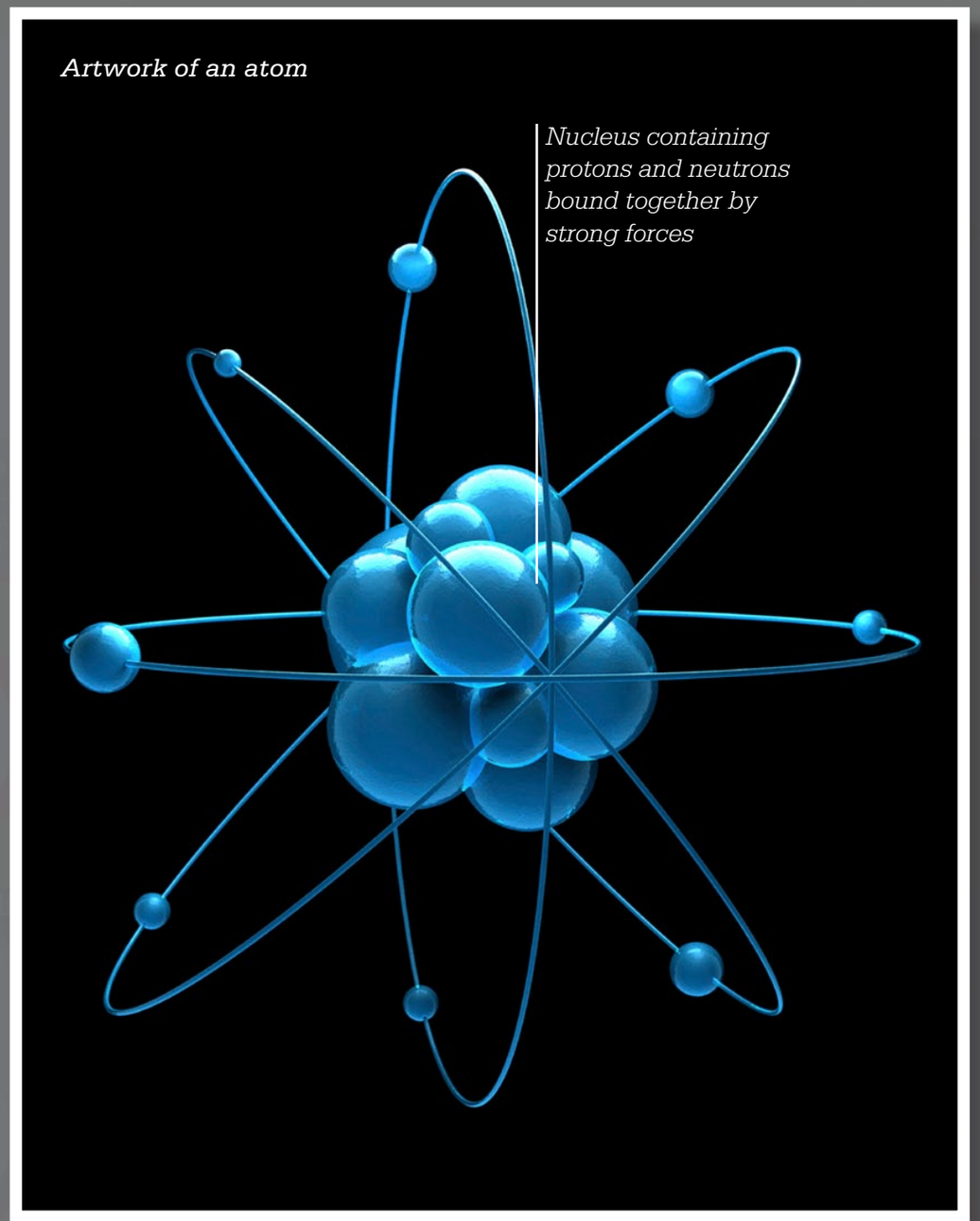
High-alloy steels are more than 5 percent one or more other elements, such as chromium, nickel, manganese, molybdenum, or tungsten. If the steel is at least 12 percent chromium, it resists rust better (or "stains less") than other types of steel, so it is called stainless steel. High-alloy steels are used in jet engines, tableware, and utensils.

The outer shell of China's National Stadium, known as the Bird's Nest, contains more than

45,000 tons of steel

More transition metals

Many transition metals are around us in daily life, from gleaming rust-resista



Nuclear fission

An **atom**, the basic component of all matter, is incredibly tiny. But stored within the nucleus—the central part of each atom—is the most powerful form of energy known. During the 20th century, scientists learned how to release this nuclear energy by splitting the atom. Splitting atoms produces electricity for lighting, heating, and cooling in homes and schools, and is used to power submarines and satellites. Nuclear technology also has medical and industrial applications.

The process of splitting an atom's nucleus is called nuclear fission. *Fission* means "splitting." It is possible to force the nuclei of some atoms to break into two essentially equal parts. Once this process has started, the nuclei continue to divide at extremely rapid rates.

Imagine a football field covered with mousetraps, each holding a ball in its jaws. Someone in the stadium throws another ball onto the field. The ball bounces and hits one of the mousetraps, causing it to release its ball. Now there are two balls bouncing around the field. They hit two more mousetraps, releasing two more balls. Suddenly there are four bouncing balls, then eight, sixteen, and so on. Soon the field is full of bouncing balls. That's a chain reaction. If left alone, a nuclear chain reaction is very fast. Huge numbers of nuclei can split in a millionth of a second. In a nuclear reactor, the fission of atoms is controlled and the energy released is used to make electricity.

Ernest Rutherford
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Nicolaus Copernicus
Isolated in Darmstadt in 1996, Copernicium honors the 16th-century Polish astronomer Copernicus.

26
Fe

Since ancient Egyptian times, people have been able to extract

It is estimated that, worldwide,

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atom *noun*

An atom is the smallest natural building block of matter. The word *atom* comes from the Greek word *atomos*, meaning "indivisible"—although it was later found that the atom actually can be divided, through nuclear fission. The atom is the smallest part of a substance that can exist with the characteristic properties of one of the known elements.

Each atom contains a small, dense, positively charged nucleus made up of protons and neutrons bound together by strong forces. The nucleus is surrounded by enough negative electrons to make the atom as a whole electrically neutral.

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Iron is a he
Gold is 19
heavier th
as much a
dense and

1	*Gold*	
2	*Mercury*	
3	*Silver*	655 lb. per cu. ft. (10,492 kg per cu. m.)
4	*Copper*	559 lb. per cu. ft. (8,954 kg per cu. m.)
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4 5

Periodic table complete collection

Collect more transition metals

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Fe

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carbo

ore *noun*

Ores are rocks and minerals from which useful metals can be extracted. Many rocks and minerals contain tiny amounts of valuable metals, but only those containing enough to make digging them from the ground worthwhile are called ores. Various factors determine whether mining an ore will be worthwhile, including the value of the metal in the ore, the size of the ore deposit, and how easily mined the ore is.

Before any ore can be mined, it must be found. Ore minerals are found scattered throughout rock, in layers called beds or in thin strands called veins. Although most ores are found underground, rocks on the surface may contain ores, too.

Densi

Iron is a he
Gold is 19
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dense and

1	*Gold*	
2	*Mercury*	
3	*Silver*	655 lb. per cu. ft. (10,492 kg per cu. m.)
4	*Copper*	559 lb. per cu. ft. (8,954 kg per cu. m.)
5	*Iron*	491 lb. per cu. ft. (7,865 kg per cu. m.)

Periodic table complete collection

Collect more transition metals

More transition metals

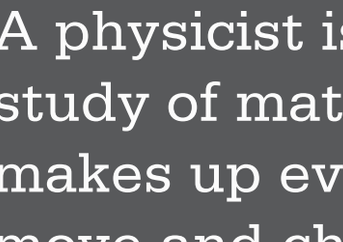
Many transition metals are around us in daily life, from gleaming rust-resista

74 W Tungst

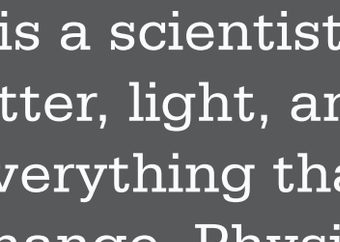
Tungsten ligh
Traditional lighth
tungsten filamen
withstand hot te

104 Rf Ruther

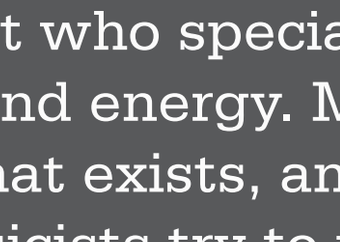
Ernest Rutherford
The 104th element is named after British scientist Ernest Rutherford, known as the father of nuclear physics.



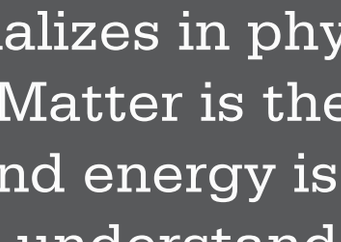
Dubna, Russia
Dubnium is named for Dubna, Russia, where it was found at the Joint Institute for Nuclear Research.



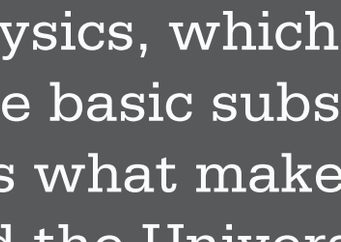
Glenn T. Seaborg
American Glenn T. Seaborg was one of several scientists who discovered this element in Dubna in 1974.



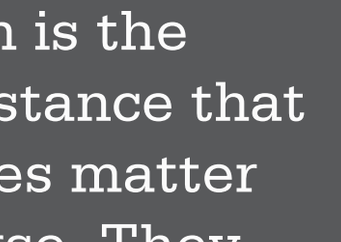
Niels Bohr
Bohrium was synthesized in 1976 by Soviet scientists and named after Danish **physicist** Niels Bohr.



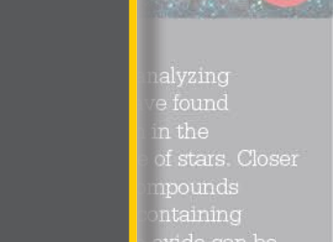
Peter Armbruster
Armbruster codiscovered hassium, named for the Latin word for Hesse, Germany, where it was found.



Darmstadt, Germany
This radioactive element is named after Darmstadt, Germany, where it was first created.



Wilhelm C. Röntgen
Roentgenium was made in Darmstadt in 1994, exactly 100 years after Röntgen discovered X-rays.



Nicolaus Copernicus
Isolated in Darmstadt in 1996, Copernicium honors the 16th-century Polish astronomer Copernicus.

physicist *noun*

A physicist is a scientist who specializes in physics, which is the study of matter, light, and energy. Matter is the basic substance that makes up everything that exists, and energy is what makes matter move and change. Physicists try to understand the Universe. They have found and isolated the elements, examined the tiniest particles, and created new materials.

Modern physics deals with the basic structures and behaviors of matter, light, and energy on a very large or very small scale—from distant stars and galaxies to the most minuscule particles.

Aluminum [Poor metals]

HOME

13
Al

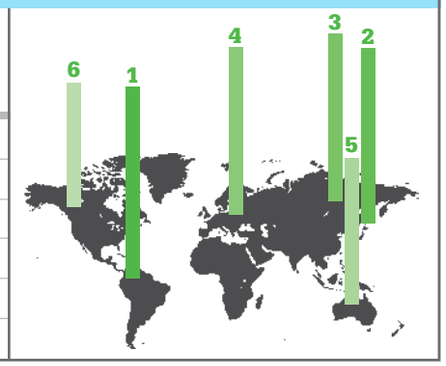
Aluminum is a very light metal with a bright silvery luster. It is an excellent reflector of light, making it important for use in spacecraft, especially for reflecting away the sun's rays to cool craft. Back on Earth, space blankets (foil-like sheets made of aluminum alloys) keep runners and climbers warm because they trap heat in the body.

Most modern mirrors are made using a thin, reflective coating of aluminum, and solar panels are backed with it. Aluminum is frequently used for packaging food—bottled products use aluminum caps and seals, and aluminum cans hold soft drinks and heat-processed foods.

World's top aluminum can recyclers

Aluminum never corrodes (becomes rusty), so it can be recycled forever. More than a third of all the aluminum currently produced globally originates from old stock.

1	*Brazil*	*98.2%*
2	*Japan*	*89%*
3	*China*	*85%*
4	*Europe*	*84%*
5	*Australia*	*70%*
6	*North America*	*57.4%*



Brazil recycles

1.7 million

cans per hour

More aluminum things to collect

Periodic table complete collection

Soft drinks inside cans are carbonated (infused with carbon dioxide gas) to make them fizzy. They are sealed in the cans under pressure, to keep the air bubbles from dissolving—until the tab is pulled.

Most drink cans are made of recycled aluminum.

A can starts life as a coiled aluminum sheet, which is sent through a press that punches out shallow cans. Next, another machine makes them taller and thinner.

Aluminum [Poor metals]

13
Al

Aluminum

An abundant metallic element, aluminum is estimated to form about 8 percent of the solid portion of Earth's crust. People have been able to extract the bluish-white metal from its ores since the 1800s, but the cost of refining it was so high that it was a luxury. Emperor Napoleon III of France had his finest dinner spoons made of it. **Metallurgists** did not discover ways to refine aluminum cheaply until 1886. Then aluminum became an important part of nearly every industry in the world, taking over from many of the **ferrous** (iron-containing) metals traditionally used.

Like all the poor metals, aluminum is very light and flexible but not very strong. Aluminum weighs two-thirds less than other common metals such as iron, copper, nickel, or zinc. Its lightness makes aluminum useful in the manufacture of building materials, bus and truck bodies, and car and airplane parts. About 90 percent of the total weight of a typical four-engine aircraft is aluminum.

Aluminum conducts electricity well and has replaced copper in high-voltage electric lines. Since it is a good conductor of heat, aluminum makes excellent cookware because heat spreads evenly throughout pans made of it.

US candy maker Hershey's uses

133 (344 sq km) square miles

of foil a day to wrap its chocolates

More aluminum things to collect

Aluminum is widely used in the food processing industry, both in containers and in the products inside! Aluminum foil is used for wrapping foods at home, and many of the containers in your kitchen and bathroom also feature aluminum. Mineral salts containing aluminum are used in several skin-care products and in the refining processes of some flours, cheeses, and pickled foods.

Collect more poor metals

Periodic table complete collection

Cutlery

Aluminum alloys are commonly used to make cutlery and kitchen utensils.

Aluminum foil

The “tinfoil” used for cooking and wrapping is usually made of aluminum.

Lipstick tube

Cosmetics are often packaged in containers made with aluminum.

Food can

Once made of tin, food cans are now aluminum or steel.

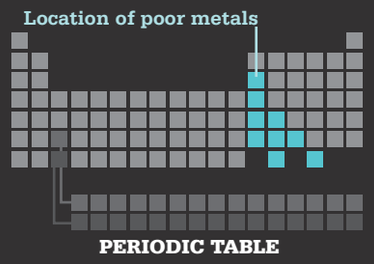
Cooler lunch box

Aluminum coatings inside bags keep food cool.

Paint tube

Soft and flexible, aluminum creates squeezable paint tubes.

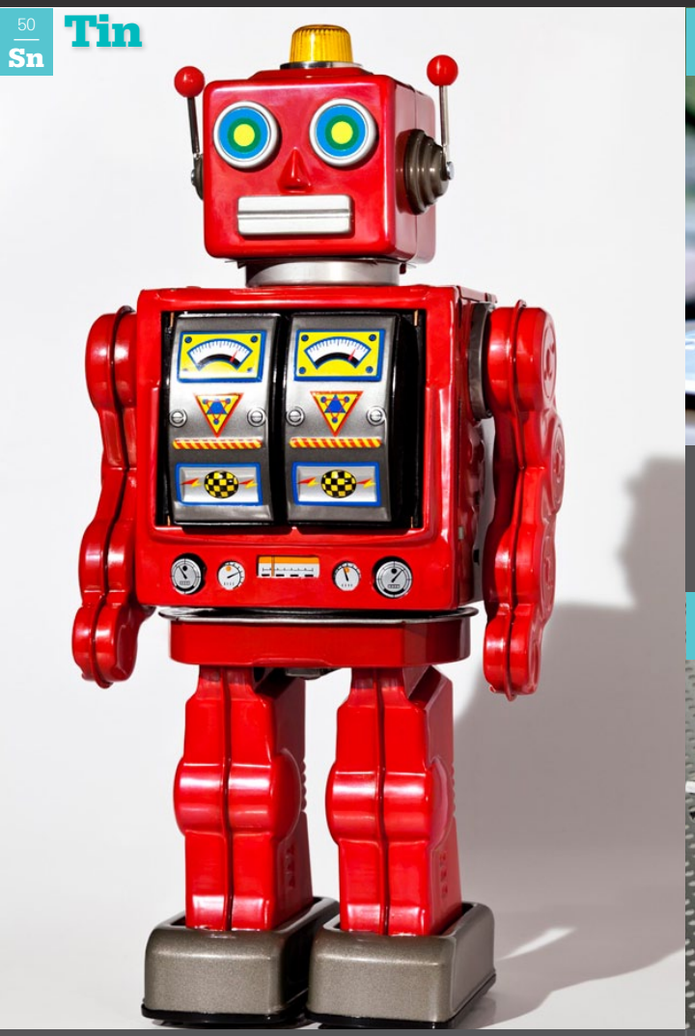
Poor metals [Softies]



The poor metals (post-transition metals) include gallium, which is used in the nuclear industry, and the highly dangerous element thallium (once made into rat poison). But they are all found in tiny quantities in many everyday items around your home—from electronic devices, toys, and solar batteries to sunscreens and face powders used on the skin!

Periodic table complete collection

50 Sn **Tin**



Tin toy robot
Tin plate has been used to make toys, including robots and vintage cars, since the 1850s. Tin toys are usually made from recycled tin, produced from scrap metal.

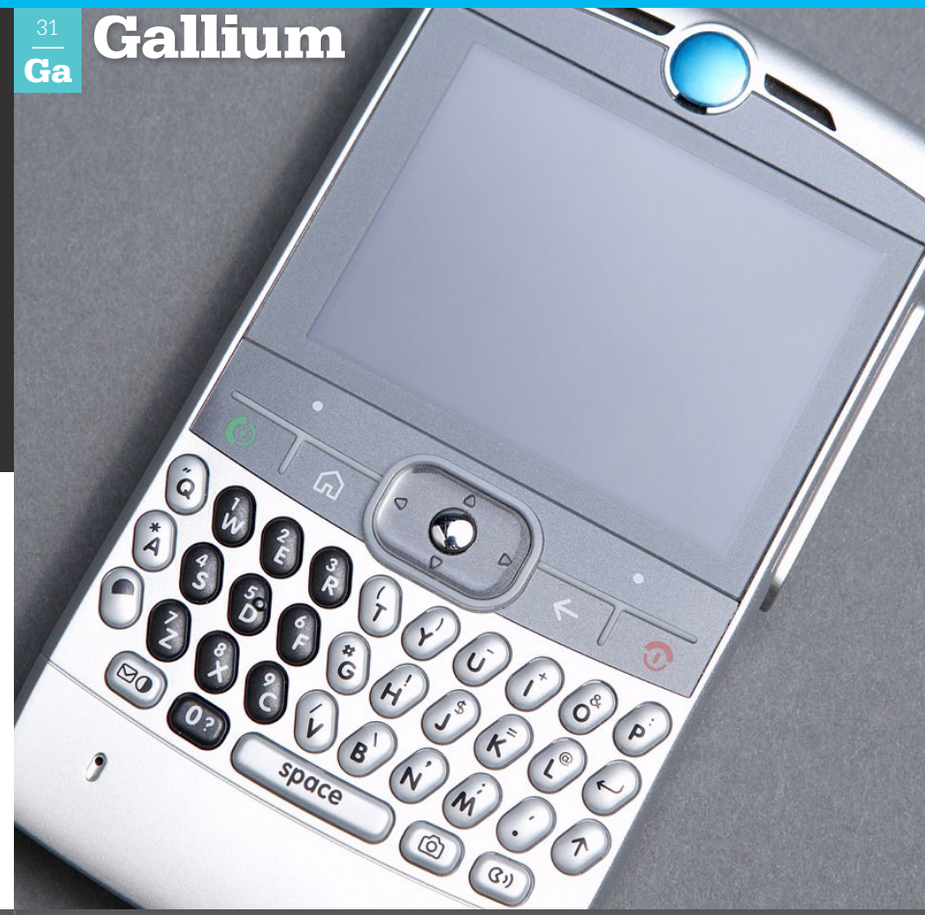
49 In **Indium**

Computer screen
Around 65 percent of indium is used to make thin films of indium tin oxide for liquid crystal display (LCD) computer screens.

83 Bi **Bismuth**

Sunscreen
Bismuth oxychloride (a mix of bismuth, oxygen, and chlorine) is often used in sunscreens and shimmery makeup.

31 Ga **Gallium**



Cell phone
Gallium, mixed with arsenic, is the poor metal most commonly found in solar cells and integrated circuits (computer chips) used to make electronic products such as cell phones.

81 Tl **Thallium**

Solar calculator
Thallium sulfide, like gallium and indium, is used in solar-powered products because of its ability to conduct electricity. This ability increases when it is exposed to light.

82 Pb **Lead**

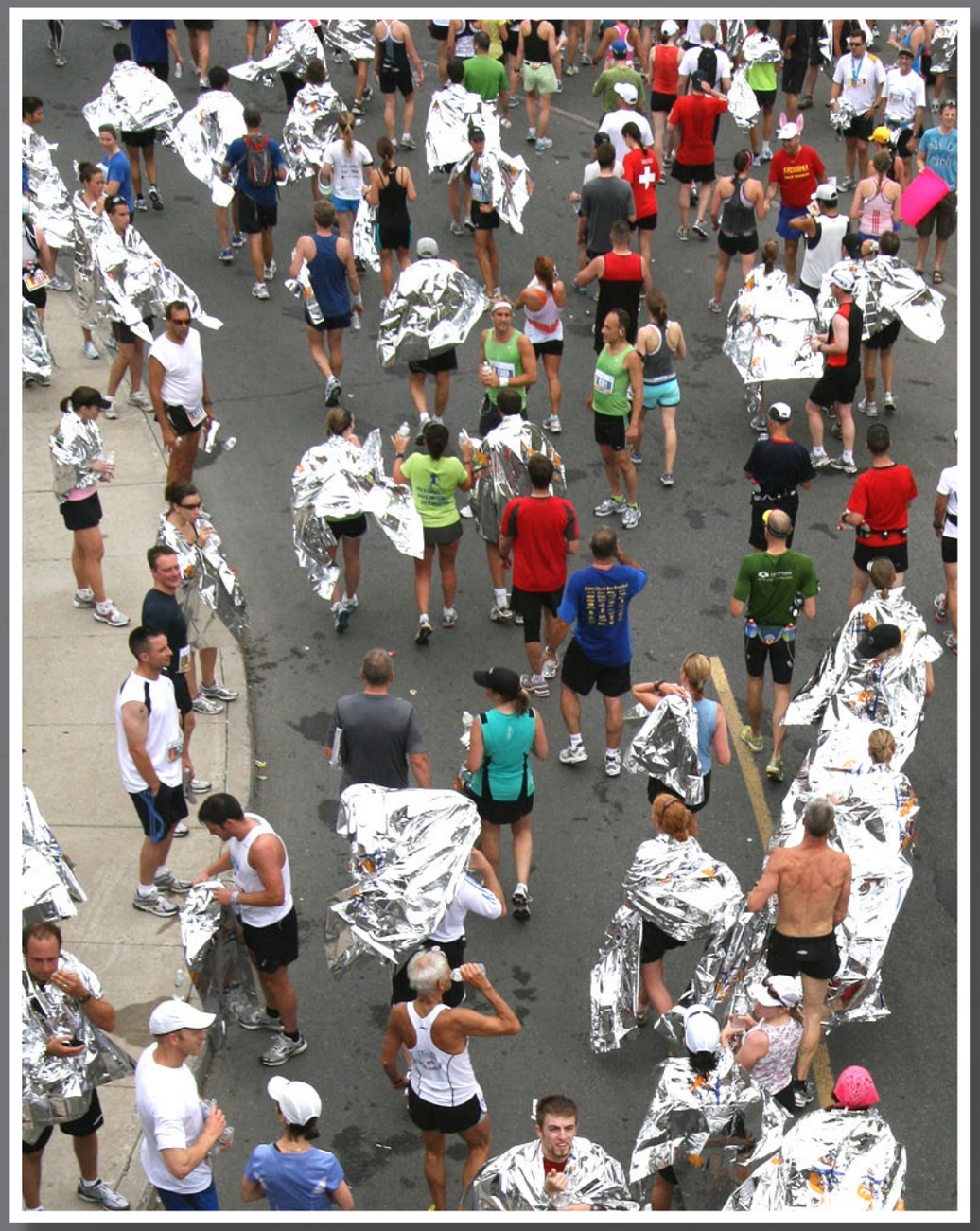
Egyptian eye kohl
Cosmetics once contained lead, including black eyeliner worn by ancient Egyptians. Lead is now known to be toxic, so it is no longer used. Instead, find a picture to add to your collection.

83 Bi **Bismuth**

Nail polish
Bismuth flakes are added to modern nail polishes to give a shimmery, pearlescent effect to the gloss.

Aluminum [Poor metals]

13
Al



Space blanket

Space blankets are thin, foil-like reflective sheets, made partly of aluminum, that reduce heat loss in a person's body. They are given to marathon runners after they have completed a race: The runners' body temperatures drop quickly when they abruptly stop exercising, but space blankets keep them warm. Space blankets are also used in emergencies to control heat loss in shock, and campers and explorers make use of their heat-conserving properties in extreme weather conditions.

Space blankets are so called because their material was developed by NASA for use in space in the 1960s. It was created by putting treated aluminum onto a very thin plastic film. The thin film is flexible, lightweight, and easy to use, and the aluminum helps redirect infrared energy—heat.

The shiny material can reflect heat away or keep heat in. So although runners use space blankets to keep from losing heat too quickly, in space the same material is often used to keep spacecraft cool. It has been used on everything from the Mars rovers to communications satellites to the Hubble Space Telescope. It is also used to prevent overheating in computers.

Thin, shiny space blankets reflect

80 percent

of your radiated body heat back

13
Al

ferrous *adjective*

Metals or alloys for which the main component is iron are called ferrous. Alloys are divided into two broad groups: ferrous alloys, with iron as the elemental metal; and nonferrous alloys, with a metal other than iron. Although iron and steel are still the most commonly used metals, nonferrous metals increase in importance as new technologies develop.

135 square miles

of foil a day to wrap its chocolates

13
Al

metallurgist *noun*

Metallurgy is the science and engineering of metals, so metallurgists investigate and examine the performance of ferrous metals (those that contain iron) such as steel and nonferrous metals such as aluminum, nickel, and copper.

There are three areas of metallurgy: extractive, physical, and manufacturing. An extractive metallurgist takes ore from the Earth and extracts its metallic elements, then refines the metal. A physical metallurgist analyzes the structure of a metal and combines metals together. A manufacturing metallurgist processes a metal into something useful—such as the engine block of a car.

of foil a day to wrap its chocolates

13
Al

Aluminum is a very light metal with a bright silvery luster. It

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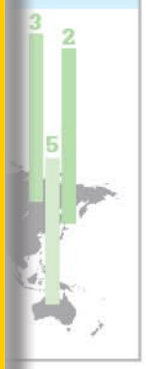

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reflector *noun*

A reflector is a shiny surface or device that reflects light or heat. Typical reflectors are used to redirect light from its source to another surface. A reflector can be a piece of glass, metal, or other material such as a red reflector on the back of a motor vehicle or bicycle.

The most reflective metals are silver and aluminum, both of which are used to make mirrors and solar panels. They can be applied to glass at various thicknesses, allowing different amounts of light to penetrate. In space, mirrorlike panels or materials are used to collect and reflect solar energy—heat from the Sun.

Silicon [Metalloids]

14
Si

Silicon chips—tiny electronic circuits printed on thin wafers of silicon—have been called the most important invention of modern times. Found inside everything from pocket calculators and cell phones to computer games and laptops, they have revolutionized the electronics industry and, with it, our work and leisure activities. Elsewhere in the home, silicones—polymers with a core of silicon and oxygen—have transformed kitchen equipment, including ice-cube trays, cake molds, and oven mitts. Silicon is also the main semiconducting material in solar cells, used in solar panels to turn sunlight into electricity.

Periodic table complete collection

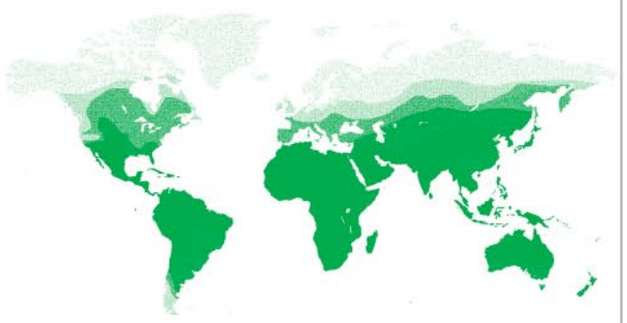
More silicon things to collect

Countries where solar panels could be most effective

The efficiency of silicon solar cells depends on the amount of sunlight they can soak up. This map measures sunlight in each area to show the amount of energy that could be generated each day.

Average daily sunshine, measured in energy hours per 3.3 sq. ft. (1 sq. m.)

1.0–1.9 *2.0–2.9* *3.0–3.9* *4.0–4.9* *5.0–5.9* *6.0–6.9*



Silicones used in bakeware are made from silicon and other chemicals. Silicones can be formed into anything from runny liquids to flexible solids, such as these cupcake molds.

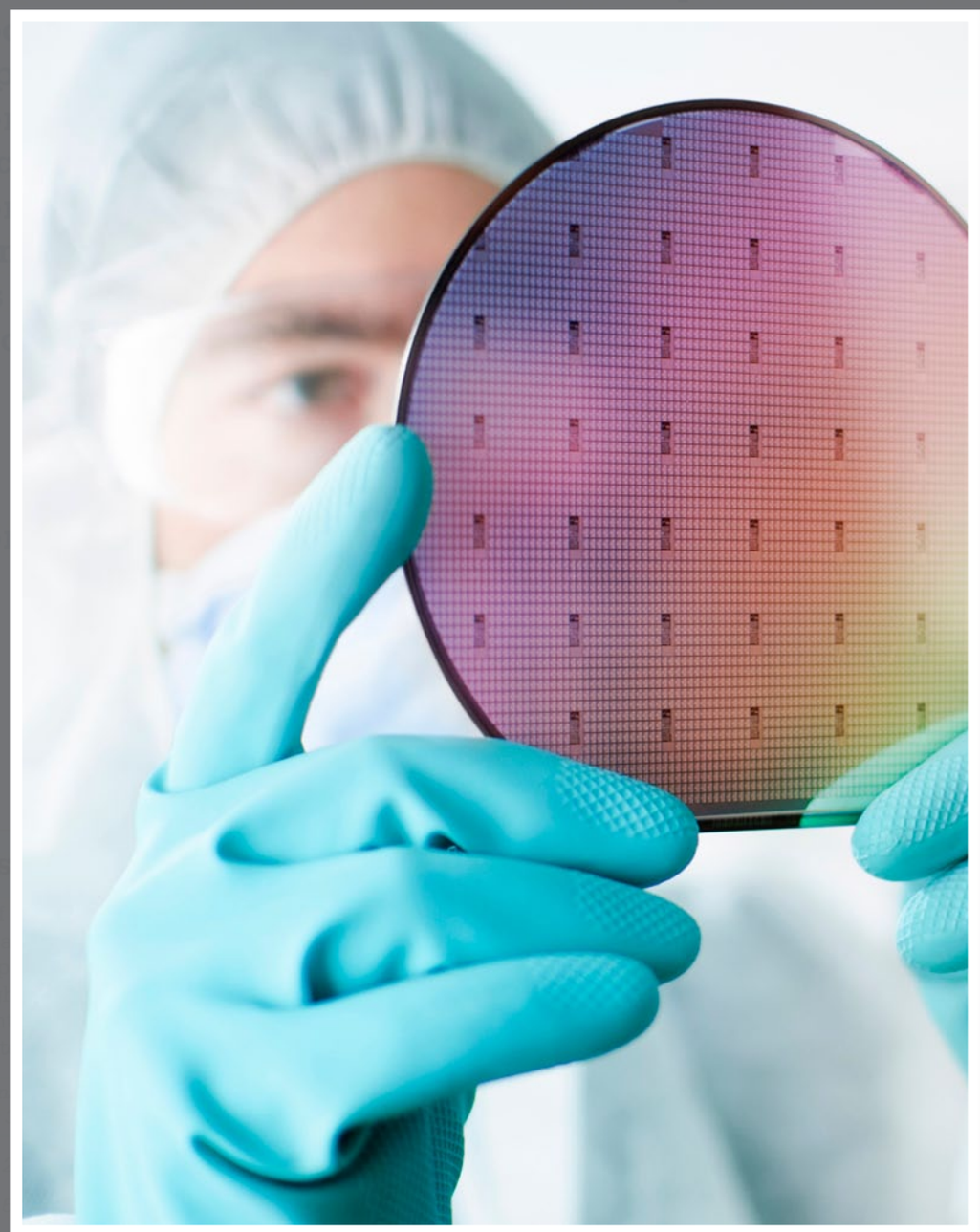
Nonstick molds made of silicone are an alternative to metal and paper bakeware. Unlike the silicon used for wafers, which is brittle, silicone is rubberlike and flexible.

Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

Collect more metalloids

Silicon [Metalloids]

14
Si



Silicon

Silicon is the second-most abundant element in our planet's crust. Oxygen (47.3 percent) and silicon (27.7 percent) make up three-fourths of Earth's crust. Most of the crust's silicon exists as silicon dioxide, or silica; we are familiar with this as sand or quartz. Silica sand is quarried from pits and then undergoes a refining process. Although silicon can be prepared in several ways, it is generally made commercially by heating silicon dioxide in an electric furnace.

Silicon of ordinary purity is used in alloys, which the element forms with most metals. Such alloys include ferrosilicon, used to make very resistant silicon steel and silicon copper, and combined with tin to make the silicon bronze used in telephone and telegraph wires. Silicon is also combined with certain ceramic materials to make cermets (ceramics mixed with metals) and other heat-resistant materials.

The silicon used in silicon chips for the electronics industry has to be exceptionally pure and clean, and it is further refined in dust-free conditions. The lowest acceptable purity for electronics-grade silicon is 99.9999999 percent. Along with elements such as boron, gallium, phosphorus, and arsenic, it is used to make transistors and other semiconductors for use in anything from video games to cars.

A strand of silicon fiber can transmit

trillions

of bits of information a second

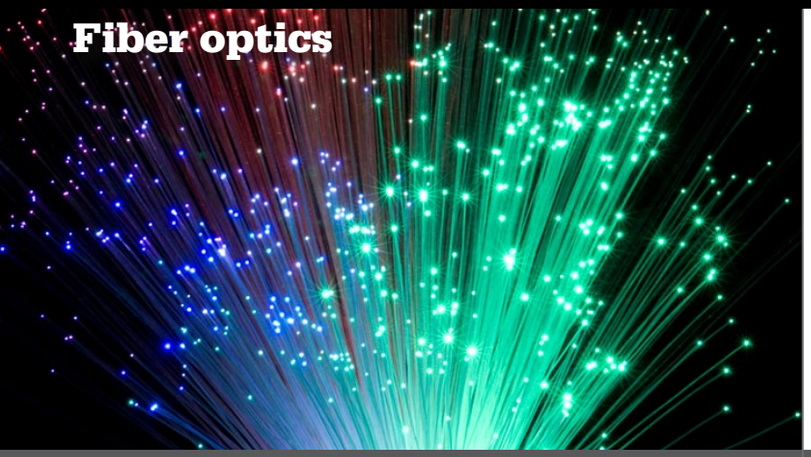
More silicon things to collect

Silicon is the most common metalloid and the second-most abundant element in Earth's crust, making up 27.7 percent of it. Most of this is found as silicon dioxide, or silica, which we usually see as sand or quartz. Silica is used to make glass and ceramics, in food (to keep it from sticking together), in cosmetics, and in computing. Silicones—made from silicon and oxygen, along with carbon, hydrogen, and other chemicals—are flexible materials used to create everything from swimming caps to computer accessories.

Periodic table complete collection

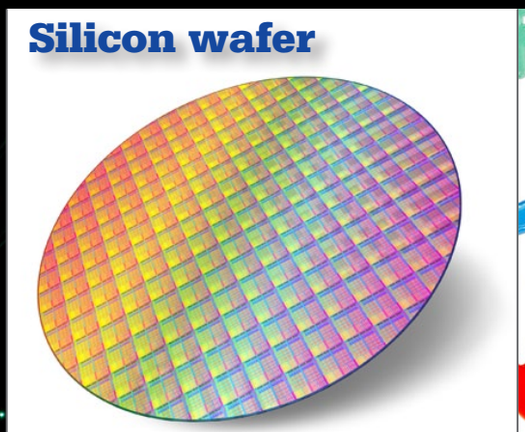
Collect more metalloids

Fiber optics



Thin fibers of pure silica glass, only slightly wider than strands of hair, carry information coded in beams of light. They can carry telephone calls, and the messages and images we send over the Internet.

Silicon wafer



The back of a silicon wafer is pure silicon. On the top, millions of microscopic **transistors** make up a thousand computer microchips.

Gel sticker

Silicones belong to a large family of polymers. Some are rubbery solids, and some are fluid gels, like the gel contained in these stickers.

Games controller cover

As well as being flexible and easy to mold, silicone rubber has antidust and nonslip properties that are especially useful for protecting electronics products.

Sand

Silica is a component of sand, but unlike the sand on beaches, which is mixed with other minerals, the silica sand used in the manufacture of silicon chips is purer and paler and has to be dug from deep pits.

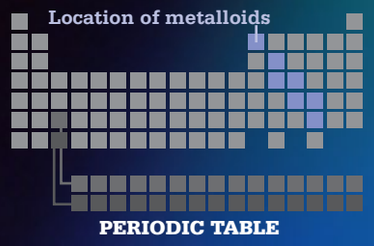
Swimming goggles

Silicone is so tough that despite frequent contact with water and cold temperatures, it will not crack or break.

Wristband

To create wristbands, raw silicone material is inserted into metal molds engraved with inscriptions, then heated to 392°F (200°C).

Metalloids [The techy team]



The metalloids—boron, silicon, germanium, arsenic, antimony, tellurium, and polonium—all show some characteristics of metals and some of nonmetals. All of them are semiconductors, so they are useful in creating electronics products. Germanium, antimony, and tellurium are used together to create memory chips. Germanium, like silicon, is used in solar cells, and it is often added to metals to create coins and medals.

5 B **Boron**

Cleaning liquid
Boron, mixed with other chemicals, is widely used in detergents, disinfectants, and other household cleaning products.

32 Ge **Germanium**

Camera lens
Glass containing germanium dioxide is used in specialized camera equipment, from night-vision lenses to wide-angle lenses.

51 Sb **Antimony**

Printing
Antimony is used in inks; when blended with tin and lead, it also becomes an alloy used for making type letters.

52 Te **Tellurium**

Colored glass
Tellurium is used to create tinted glass, like the kind found in some car windshields, and to color ceramics.

84 Po **Polonium**

Antistatic brush
Radioactive polonium is rarely used, except in antistatic brushes that clean dust off reels of film.

33 As **Arsenic**

Light-emitting diode
Arsenic is used as a semiconductor inside light-emitting diodes (LEDs), tiny lightbulbs that fit into electrical circuits. They do not get hot (like traditional lightbulbs do), so they can be used in electronics equipment from thin TVs to watches.

Solar cell

A solar, or photovoltaic, cell is a device designed to convert the energy in sunlight into electricity to provide a reliable and environmentally friendly source of energy. Single solar cells are connected together into solar panels, used to provide power for larger objects. Wires attached to the cells gather the electricity, which may be stored in batteries for later use. Most solar cells use silicon as the main semiconducting material that harnesses the Sun's rays, but other elements—including gallium, copper, indium, selenium, and cadmium—can also be used.

Solar cells are used in many products. Single solar cells provide power for wristwatches and handheld calculators. Larger cells are installed in road signs, streetlights, boats, homes, and businesses. Some companies build solar arrays (collections of panels) on rooftops and south-facing walls or as thin layers on window glass to boost their energy supply. More powerful, multiple-panel arrays are used mainly to provide power in remote places, such as oil-drilling platforms, where the alternative—laying long-distance power lines supplied by power plants—is too expensive. Once the equipment is installed, solar energy is free to use and is a renewable source of power that will not run out, unlike traditional electricity, which relies on fossil fuels such as coal, oil, and natural gas.

Enough sunlight falls on Earth in

60 minutes

to meet all the world's energy needs for a whole year!

More silicon things to collect

Transistor

A transistor is a small electronic amplifying device (something that can increase or decrease the power of a force or signal) made from a wafer of semiconducting material, usually silicon or germanium. It acts as a switch, controlling the flow of electrical current in a computer chip. Silicon transistors today are made as parts of integrated circuits (silicon chips) that consist of many transistors and the connections between them.

Since the late 1940s, transistors have transformed electronic equipment, including radios, television receivers, home sound systems, and computers, enabling far slimmer and smaller electronics devices to be built over the years. Millions of tiny transistors may be used in a single computer, saving space and power and reducing heat output.

Because of its small size, the transistor is essential in such miniature devices as hearing aids and heart pacemakers, as well as MP3 players and handheld calculators. Researchers are developing transistors so tiny that about 200 million of them could fit on the head of a pin.

It is estimated that more than 10,000,000,000,000,000,000 transistors are made a year!

14
Si

Silicon chips—tiny electronic circuits printed on thin wafers

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polymer *noun*

A polymer is any one of a large number of natural or synthetic (man-made) chemical compounds made up of many molecules strung together to form long chains, and sometimes more complicated structures.

Plastics such as polystyrene and polyethylene are polymers, as are silicones. Many of the things you use every day are made of them. Athletic shoes have polymers in their soles, their fabric, and their gel insoles. “Smart” polymers, developed by scientists, are used in construction, firefighting, and the textile industry.

Count

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Average daily sunshine, measured in energy hours per 3.3 sq. ft. (1 sq. m.)

1.0–1.9 2.0–2.9 3.0–3.9
4.0–4.9 5.0–5.9 6.0–6.9

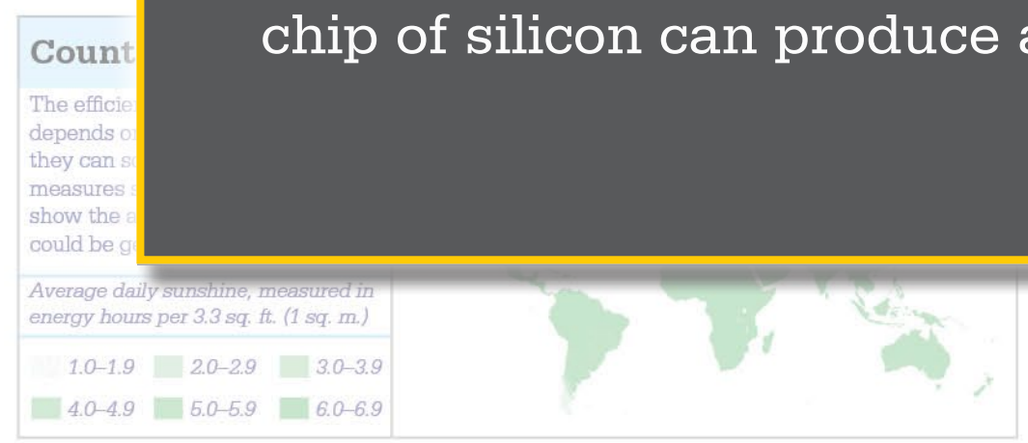
Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

14
Si

semiconductor *noun*

A semiconductor is a substance, such as silicon, that conducts electricity more easily than an insulator (such as rubber) but less easily than a conductor (such as metal).

Silicon is one of the few elements (along with fellow metalloid germanium) that can be made to act as a semiconductor. In pure form, it will not conduct electricity, but if impurities are introduced, it becomes a conductor. The careful placement of impurities in a chip of silicon can produce a circuit of electronic components.



Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

14
Si

silicon chip *noun*

A silicon chip, or microchip, is an integrated circuit used in electronic equipment that acts like a miniature brain. The miniaturized circuit is etched on a thin wafer of pure silicon and can contain millions of components. A chip is less than 0.2 square inches (1 sq. cm.) in area and just 0.02 inches (0.5 mm) thick, and it can hold more than 20 layers of complex circuit lines and transistors.

Around 1,000 chips are created on one circular wafer. The wafer is then separated into individual integrated circuits, which are tested and surrounded by protective plastic, ceramic, or metal.

Silicone products can handle temperatures from freezing to 500°F (260°C) without melting, cracking, or losing their shape.

Carbon [Nonmetals]

6
C

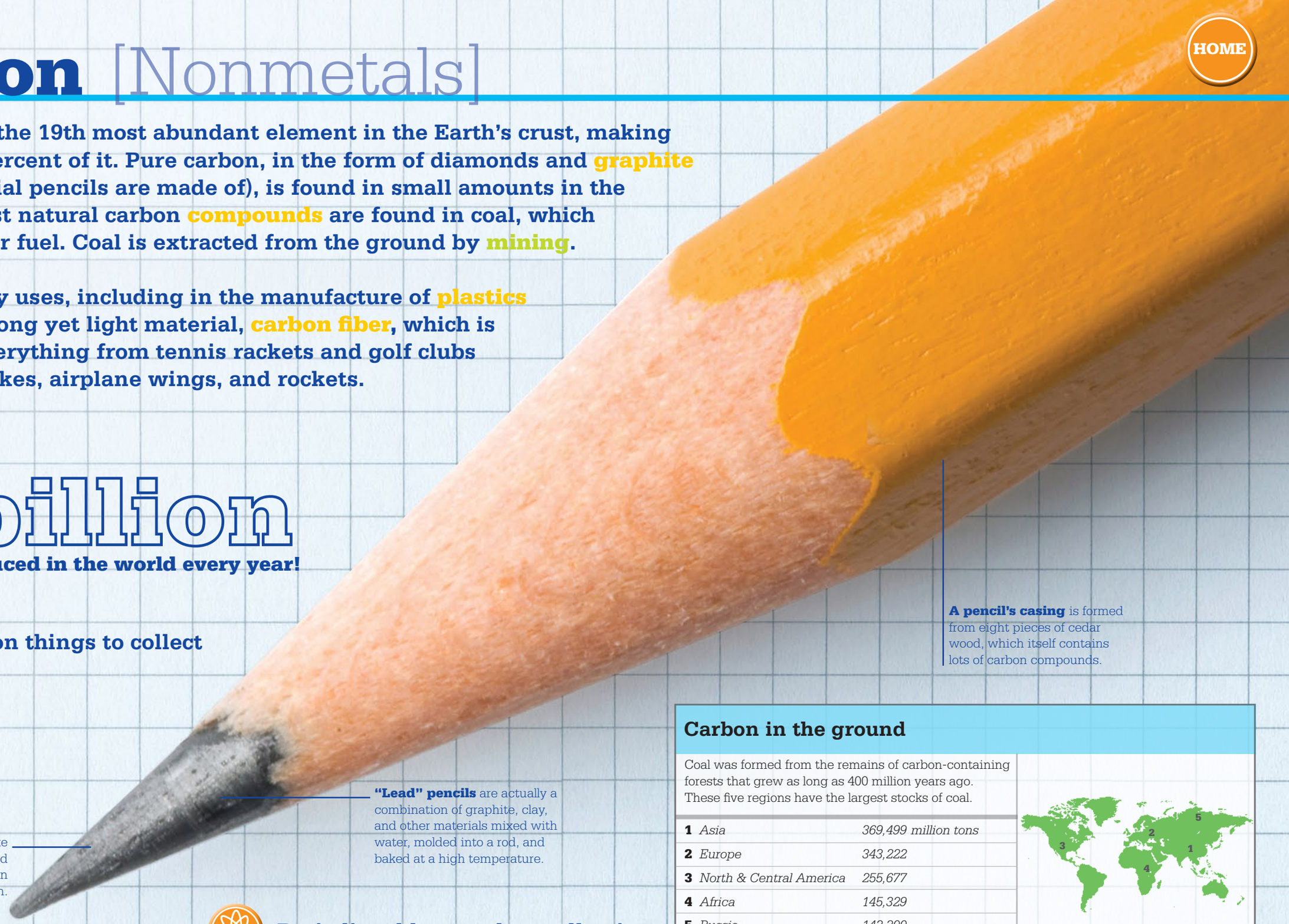
Carbon is the 19th most abundant element in the Earth's crust, making up 0.027 percent of it. Pure carbon, in the form of diamonds and graphite (the material pencils are made of), is found in small amounts in the Earth. The richest natural carbon compounds are found in coal, which can be burned for fuel. Coal is extracted from the ground by mining.

Carbon has many uses, including in the manufacture of plastics and of a very strong yet light material, carbon fiber, which is used to make everything from tennis rackets and golf clubs to lightweight bikes, airplane wings, and rockets.

More than

14 billion

pencils are produced in the world every year!



"Lead" pencils are actually a combination of graphite, clay, and other materials mixed with water, molded into a rod, and baked at a high temperature.

Graphite, used to make pencils, is a soft black solid and the most common form of natural carbon.

A pencil's casing is formed from eight pieces of cedar wood, which itself contains lots of carbon compounds.

More carbon things to collect

Carbon in the ground

Coal was formed from the remains of carbon-containing forests that grew as long as 400 million years ago. These five regions have the largest stocks of coal.

1	*Asia*	*369,499 million tons*
2	*Europe*	*343,222*
3	*North & Central America*	*255,677*
4	*Africa*	*145,329*
5	*Russia*	*143,300*

Periodic table complete collection

Collect more nonmetals

Carbon [Nonmetals]

6
C

Carbon is the 19th most abundant element in the Earth's crust, making

Carbon

Carbon is extremely versatile because its atoms form **bonds** with other atoms, especially other carbon atoms. Diamonds and graphite look completely different, but they are both made from arrangements of carbon atoms. Graphite, the most common natural form of carbon, is a soft black solid that can conduct electricity. In graphite, carbon atoms are arranged in sheets resembling chicken wire. Graphite is soft because these sheets slide easily over one another.

Diamond is one big molecule of carbon atoms. It is the hardest known natural substance, so it is very useful in making cutting tools. Diamonds easily separate white light into colors, which makes them highly desirable as gemstones. In diamonds, each carbon atom is bound to four more carbon atoms in a three-dimensional arrangement. Diamonds do not conduct electricity.

Another form of pure carbon is the soccer-ball-shaped molecule carbon-60, which has 60 carbon atoms arranged in a sphere. The pattern is similar to that of structures called geodesic domes, which were designed by US engineer R. Buckminster Fuller. Hence, this form of carbon has been called buckminsterfullerene, or a buckyball. It has been used in fiber optics to send information over the Internet.

Scientists found a star made of diamond

2,485 miles (4,000 km)

wide, created from crystals of carbon

More carbon things to collect

Here are some more things made with carbon-containing compounds that you might see around your home. Carbon atoms are used to create thin fibers to form a material found in chairs, cooking pans, and sports gear. Powdered carbon is used in medicine and paints. Hydrocarbons, such as gas and oil, create plastics. Carbon compounds are even used to make electronic goods.

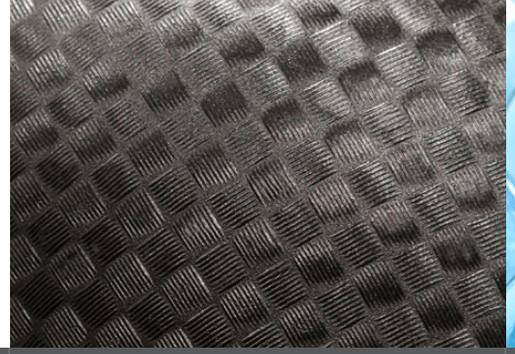
Periodic table complete collection

Collect more nonmetals

Bicycle

Top-quality bikes have graphite frames and compounds of carbon in their tires.

Carbon fiber



Fabric woven from thin fibers of carbon can be used in anything from clothes to cars.

Plastic

Carbonated drinks and the plastic bottles they come in are made with compounds of carbon.

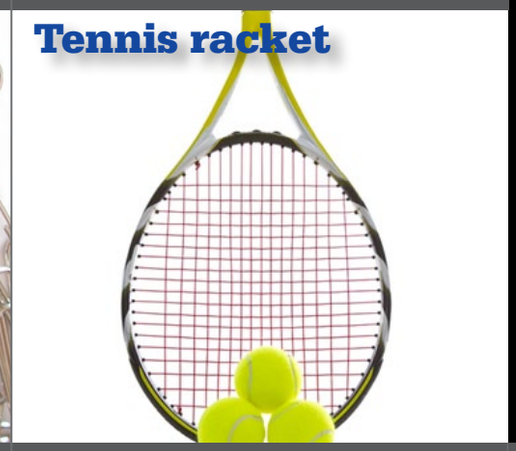
Charcoal

Charcoal for grilling is a form of carbon.

Paper clip

Carbon is added to iron to make steel.

Tennis racket

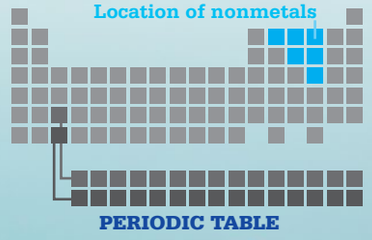


Graphite frames are light and strong.

Edison lightbulb

Lightbulbs often contain looping carbon filaments, though tungsten filaments are more common now.

Nonmetals [The popular team]



Carbon, nitrogen, oxygen, phosphorus, sulfur, and selenium are nonmetals. You'll find them in a huge variety of things, including the ball bearings of many skateboards. Nitrogen is used to freeze many everyday foods. Sulfur is used to preserve food, bleach textiles, and create paints, while phosphorus is used in fertilizers and detergents. Selenium, a mineral in some foods, is also used in dandruff shampoo!

Periodic table complete collection

7 N Nitrogen

Skateboard bearing
A compound of nitrogen and silicon is added to the small but perfectly round and smooth metal balls used around a skateboard's axles to reduce friction.

7 N Nitrogen

Plant life
There is more nitrogen than any other element in plants—in their leaves, tissues, and roots.

Oxygen 8 O

Balloons
Oxygen is colorless, odorless, and tasteless. However, you can collect it in a container by blowing into a balloon! Oxygen makes up 20.95 percent of the volume of dry air.

16 S Sulfur

Garlic
Sulfur is found in garlic—one of the reasons that the strong-smelling bulb is thought to be good for health.

16 S Sulfur

Glow-in-the-dark paint
Sulfur is added to luminous paints to make them glow, including those used on watch dials.

34 Se Selenium

Brazil nuts
Brazil nuts are one of the best sources of selenium you can eat. Selenium protects body cells.

15 P Phosphorus

Detergent
Phosphates are used in soaps. Choose an organic product whose waste does not harm the environment.

AMAZING ELEMENTS

Kilauea volcano 16 S
Volcanoes blast sulfur gas that hisses, sputters, and smells like rotten eggs. Yellowish-green sulfur crystals are formed from the gas.

Carbon [Nonmetals]

Mining

Mining is the extraction, from the earth or oceans, of minerals or other materials such as coal. Earth does not give up its mineral riches easily. People must tear them out with picks and shovels, drills, and explosives. Coal was first discovered in places where it sticks out of the ground. Anthracite, or hard coal, is shiny and black and is the coal that is closest to pure carbon. It burns slowly, with a clean flame, and is good for heating houses.

Deep, or underground, mining is the method that has been used for centuries. Underground mines are one of three types—shaft, slope, or drift. The type depends on the kind of opening that lets the miners in and out. In shaft mines, shafts are dug straight down into the ground, and elevators are installed. In slope mines, the coal is reached via slanting tunnels. And drift mines use horizontal tunnels—into the side of a hill, for example. The earliest mining method was to chop away at the coal face, or wall, with pickaxes. Today, most mines use a continuous mining machine. This digs the coal from the face with hardened teeth mounted on a drum. Coal is thrown onto a part of the machine that rakes it up and loads it onto cars or conveyor belts.

Fast modern conveyor belts shift

16,000 lb. (7,527 kg)

of coal a minute from mines

Carbon [Nonmetals]

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Carbon is the 19th most abundant element in the Earth's crust, making

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bond *noun*

A chemical bond is an attractive force that holds together the atoms, or groups of atoms, in different elements.

Every element is made up of atoms, tiny particles far too small to be seen even through a microscope. Each atom is made up of several types of even smaller particles. Atoms in one element can bond, or join, with atoms in another element to form a new substance called a compound. The new compound is completely unique. Carbon can bond with other carbon atoms or with atoms of other elements.

2,400 times

wide, created from crystals of carbon

Collect more nonmetals

Carbon [Nonmetals]

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carbon fiber *noun*

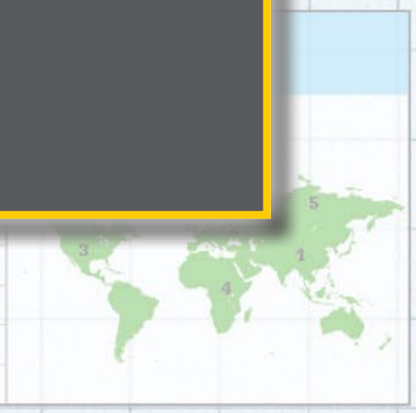
Carbon fiber is an incredibly strong but lightweight material created from ultraslim fibers that are finer than human hair. It is composed mostly of carbon atoms bonded together.

Thousands of tiny carbon fibers are twisted together to form a yarn, which can then be woven into a fabric. The fabric can also be molded into shapes, such as airplane wings. This fabric is much stronger than steel, very sturdy, and so light that engineers have found many uses for it.

Graphite, used to make pencils, is a soft black solid and the most common form of natural carbon.

water, molded into a rod, and baked at a high temperature.

2	*Europe*	*343,222*
3	*North & Central America*	*255,677*
4	*Africa*	*145,329*
5	*Russia*	*143,300*



Periodic table complete collection

Collect more nonmetals

Carbon [Nonmetals]

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compound *noun*

A compound is something that consists of a combination of two or more parts or ingredients. Elements are so versatile because they naturally combine into compounds, or can be combined synthetically, and so are found in many different products.

Carbon compounds are chemical substances in which carbon is found in combination with other elements. Many of these compounds occur naturally and many others are manufactured in laboratories and factories.

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graphite *noun*

Graphite is a form of carbon that occurs naturally as a mineral, though it can also be manufactured (man-made). Mineral graphite is black to gray and has a metallic sheen. It feels greasy and is so soft that it readily marks paper. Its most familiar use is in pencils.

Graphite is also a valuable industrial material, because it can resist high temperatures and corrosive chemicals that eat away, or destroy, other substances. It is able to conduct electricity, and it can be used as an oil. Natural graphite is created through volcanic activity.

Graphite, used to make pencils, is a soft black solid and the most common form of natural carbon.

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Periodic table complete collection

Collect more nonmetals

Carbon [Nonmetals]

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14

pencil

plastic *noun*

Plastic is a substance most commonly made from raw materials that come from petroleum. This is a liquid mixture of hydrocarbons, which are compounds of carbon and hydrogen. Petroleum is found deep below the Earth's surface, or occasionally in springs and pools at the surface.

Plastic materials are formed in a liquid state and then hardened, but their chemical composition keeps them flexible. Plastics can be formed into films and objects of practically any shape, or drawn into fibers for use in textiles. They can be used to make many of the products that we use every day, such as drink bottles, toys, packaging, and chairs.

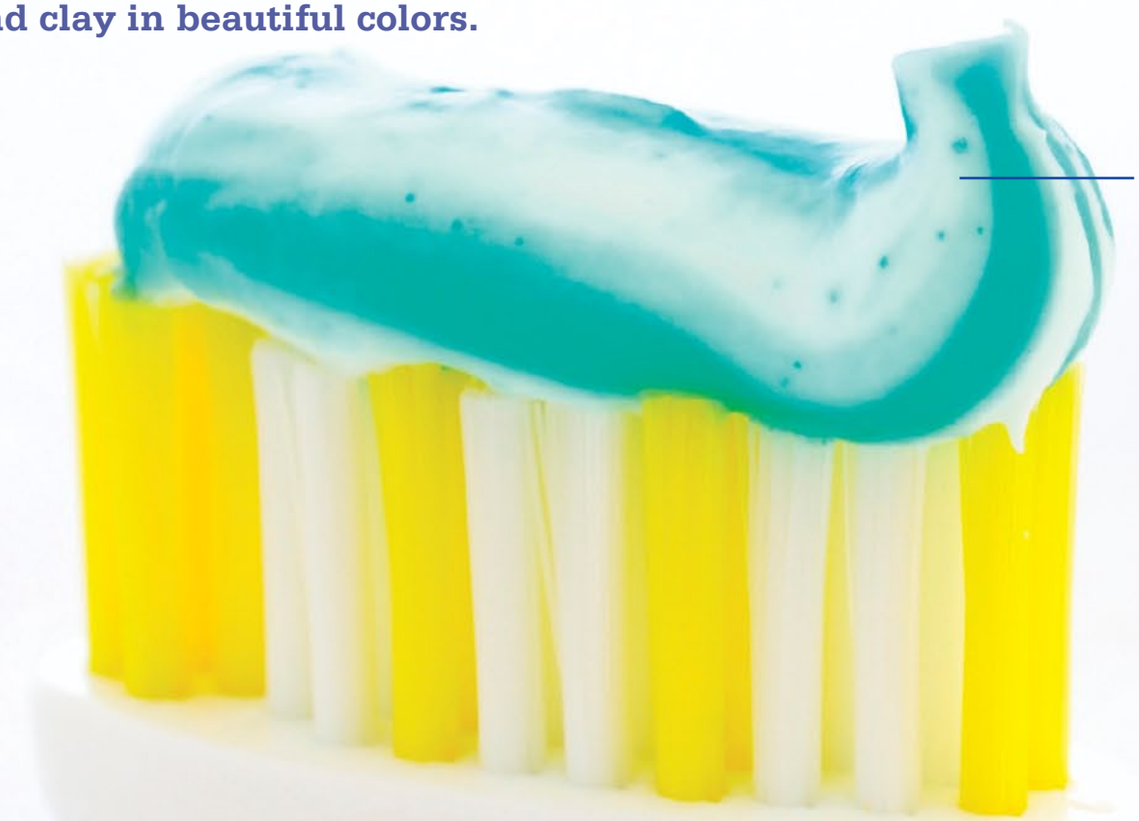
adjective: Something plastic is able to be shaped or formed.

Fluorine [Halogens]

HOME

9
F

Fluorine is the most reactive chemical element, and the lightest of all the halogens. The name *fluorine* comes from the Latin word *fluere*, meaning "to flow," which describes its effect on other elements. It has been added to iron ore (rocks and minerals containing iron) to create molten metal, and for many years it was combined with other elements to make chlorofluorocarbons (CFCs), used in aerosol sprays and refrigerators. Fluorine occurs naturally in the Earth's crust, where it is found in salts and minerals in rocks, coal, and clay in beautiful colors.



Fluorine, added to many toothpastes as fluoride, can help protect teeth from decay if applied twice a day. Try not to swallow too much, though, as fluoride may be harmful if absorbed in large amounts.

More fluorine things to collect

Humans can absorb up to

90%

of the fluoride they consume, mostly in their bones and teeth

Countries where fluoride is added to water supply

In many countries, fluoride is added to the water supply to reduce tooth decay, mostly in towns and cities. In some areas, particularly in volcanic or mountainous regions, high levels of fluoride occur naturally in water.

1	*Gabon, Hong Kong*	*80–100% of country has fluoridated water*
2	*US, Australia, Colombia, Ireland, Malaysia, Israel*	*60–80%*
3	*Canada, Brazil, Chile*	*40–60%*
4	*Argentina, Fiji, Libya, Tanzania, Zimbabwe*	*20–40%*
5	*UK, China, Denmark, Finland, Korea, Spain, Mexico, Peru, Namibia, Serbia, Vietnam*	*1–20%*

Periodic table complete collection

Collect more halogens

Fluorine [Halogens]

9
F

The mineral fluorite

Fluorine

The element fluorine is a pale yellow gas with a pungent odor at ordinary temperatures; the mineral form, found in rock and coal as fluorite (also called fluorspar), has several colors. The violet variety looks like amethyst and the green one resembles emerald, so these minerals were sometimes sold in place of the real gems. This practice led to the nicknames “false amethyst” and “false emerald” for fluorite.

Fluorite is often fluorescent, which means that when an **ultraviolet** lamp shines on it, the light reacts with the chemicals in the mineral and the mineral glows. Fluorine gas is highly poisonous and corrosive—it eats away at other materials—and is the most active chemical element, reacting with most other elements. It even reacts with some of the noble gases at high temperatures and pressures, except argon, neon, and helium. When mixed with water, fluorine will react explosively.

World reserves of fluorite are estimated at

254 million tons,

with the largest deposits in South Africa

More fluorine things to collect

Small amounts of fluorine are naturally present in water, air, plants, and animals. Humans are exposed to fluorine through food and drinking water and by breathing air. Fluorine can be found in any kind of food in small quantities; shellfish and tea contain large amounts.

Tap water

Many cities add small amounts of fluoride to the water supply—about one part per million. It is added to help strengthen teeth and prevent cavities, especially in children.

Camera lens

Fluorite is used in lenses for cameras, microscopes, and telescopes.

Nonstick frying pan

Compounds of fluorine are used to create nonstick surfaces in pans and bakeware.

Outdoor wear

Waterproof clothes contain fluorine compounds.

Tea

Both black and green teas naturally contain fluoride, particularly if they are made from leaves and twigs of mature tea plants, which absorb fluoride from the soil.

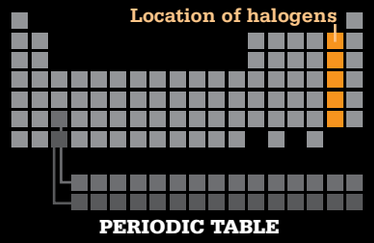
Etched glass

Hydrofluoric acid, a compound of hydrogen and fluorine, can etch patterns on glass.

Collect more halogens

Periodic table complete collection

Halogens [The active team]



The halogens are the most reactive family in the periodic table. Four of the five elements are very common and found everywhere around the house and neighborhood: fluorine, chlorine, bromine, and iodine. The fifth, astatine, is rare, highly radioactive, and produced artificially. It was not discovered until the 20th century and is most often found in research laboratories.

Periodic table complete collection

53 I **Iodine**

Halogen light
A gas from the halogen group, usually iodine (or a mixture of iodine and bromine), is added to halogen lightbulbs.

17 Cl **Chlorine**

Compact disc
Chlorine is used in the manufacture of compact discs (CDs) for video games, music, and movies.

17 Cl **Chlorine**

Water purifier
Cartridges in water purifiers, as well as purification tablets, contain chlorine. Iodine and bromine can also be used.

53 I **Iodine**

Seaweed
Kelp is a rich natural source of iodine, thought to improve the skin, the hair, and the body's resistance to diseases.

53 I **Iodine**

Dog food
Iodine is one of the trace elements often added to dog biscuits as a dietary supplement to keep pets healthy.

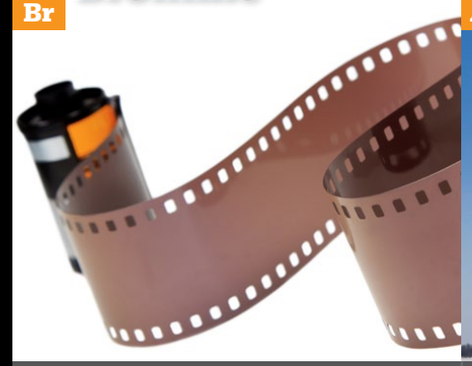
35 Br **Bromine**

Carpet
A protective coating of a bromine mixture covers carpets to help make them flame retardant (less likely to catch on fire).

17 Cl **Chlorine**

Swimming pool
Visit your local pool and you will smell chlorine. It is added to pools because it kills bacteria.

35 Br **Bromine**



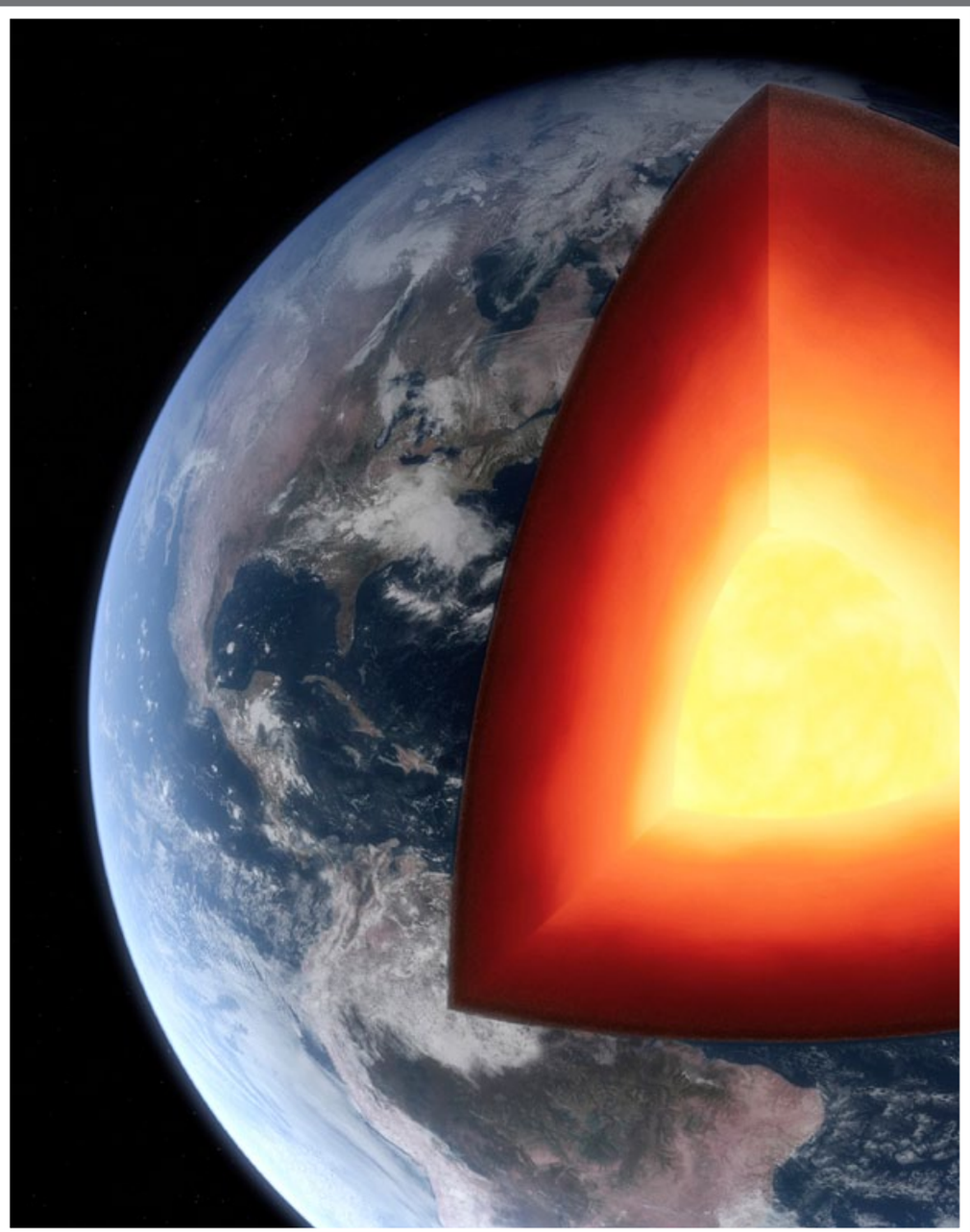
Roll of film
Silver bromide is used to make traditional film rolls for cameras. These are not needed with digital cameras!

85 At **Astatine**

Nuclear reactor
Astatine is radioactive and is made in a nuclear reactor. This is one you will not be able to collect, except as a photo!

Fluorine [Halogens]

9
F



Earth's crust

Our planet is made up of three main layers: the crust, the mantle, and the core. A thin layer of soil, sand, and loose rock covers landmasses. When we scrape this layer away, we find bedrock, the solid rock that makes up the Earth's crust.

Earth has two types of crust, made up of two types of rock. The crust under the oceans is made mostly of basalt (formed from cooled lava from volcanic action at the mid-ocean ridges). It is about 4 miles (6 km) thick. In contrast, the continental crust that lies under land is made mostly of granite and is typically about 22 miles (35 km) thick—and up to 47 miles (75 km) thick in some places.

The rocks that form Earth's crust are composed essentially of crystals, tiny particles formed from minerals of different compounds of elements. Some rocks contain only one mineral, but most rocks contain crystals of several different minerals. In fact, eight elements make up 99 percent of the Earth's crust: oxygen, silicon, aluminum, magnesium, calcium, sodium, potassium, and iron. Silicon and oxygen combine with varying amounts of the other elements to form silicate minerals, present in rocks throughout the world in different combinations.

47%

of Earth's crust is made up of oxygen mixed with other elements

9
F

Fluorine is the most reactive chemical element, and the

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chlorofluorocarbon *noun*

A chlorofluorocarbon, usually known as a CFC, is a chemical compound that contains a mix of chlorine, fluorine, and carbon atoms.

CFCs once had a wide variety of uses in industrial and consumer products, especially in helping the substances in aerosol sprays flow and disperse into the air. They were also used in air-conditioning and refrigeration units for business and home use. Eventually, though, they were found to be causing damage to the Earth's ozone layer. Because of this, manufacture and use of the CFCs that were causing the most damage were phased out through the 1990s.

5	*UK, China, Denmark, Finland, Korea, Spain, Mexico, Peru, Namibia, Serbia, Vietnam*	*1–20%*

9
F

Fluorine is the most reactive chemical element, and the

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reactive *adjective*

All of the halogens in the periodic table are highly reactive, meaning that they will easily bond (join) with other elements to make compounds. Halogens can combine with many different elements; fluorine, the most active of all, can react with virtually every other element.

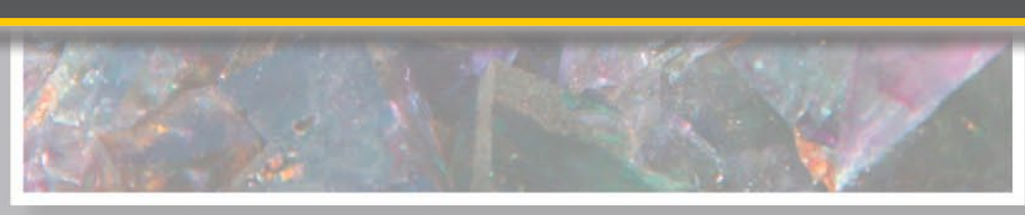
During a chemical reaction, substances change into other substances. Chemical reactions neither create nor destroy matter—they simply rearrange atoms into new combinations.

5	*UK, China, Denmark, Finland, Korea, Spain, Mexico, Peru, Namibia, Serbia, Vietnam*	*1–20%*

ultraviolet *noun, adjective*

When light passes through a prism (a solid, three-sided piece of glass), a band of colors appears. The colors change gradually from red at one end to violet at the other, with orange, yellow, green, blue, and indigo in between. This spread of colors is a spectrum. Just beyond the violet end of the visible part of the spectrum is invisible radiation with a shorter wavelength than violet light's, called ultraviolet.

When ultraviolet light strikes certain materials, the materials absorb it and produce visible light. Many minerals, oils, plant juices, and other materials have this property. Such materials are fluorescent.



with the largest deposits in South Africa

Helium [Noble gases]

2
He

Helium is the first member of the group of inert gases (also known as noble or rare gases). It is colorless and nontoxic, so it is commonly used for filling balloons used at parties, as well as weather balloons, airships, and the blimps you see at sports events. It has the lowest melting point of any element and is widely used in cryogenics—the study of things at very low temperatures—and in refrigeration.

Liquid helium has strange effects on some materials —they lose their electrical resistance when they are cooled with it, so liquid helium is useful for creating powerful magnets that can be used in machinery.

Party balloons filled with helium gas will rise because the gas is about seven times lighter (less dense) than air.

Latex (from rubber trees) is used to create most balloons because it is elastic and can expand to take any volume of helium. Foil balloons are less stretchy but longer lasting.

A popped balloon makes a bang—that is the sound of the gas escaping into the air. Helium is the most unreactive of the elements, so it does not explode.

How long helium balloons stay up

Helium-filled balloons can stay up from 12 hours to 14 days, depending on size, material, and atmospheric conditions. A weather balloon reaches a height of up to 70,000 feet (21,336 m), then the balloon bursts.

Type	Size	Duration
1 *Foil*	*3 ft. (0.9 m)*	*14+ days*
2 *Foil*	*1.5 ft. (0.5 m)*	*8–11 days*
3 *Latex/rubber*	*16 in. (40.5 cm)*	*24–36 hours*
4 *Latex/rubber*	*11 in. (27.5 cm)*	*12–18 hours*
5 *Weather balloon*	*5 ft. (1.7 m)*	*2 hours*

Periodic table complete collection

Collect more noble gases

Helium [Noble gases]

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Helium is the first member of the group of **inert gases**

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| **Latex** (from rubber trees) is

Helium

The name *helium* is derived from the Greek *helios*, meaning "sun," because it was first observed during an 1868 solar eclipse by French astronomer Pierre Janssen. It was isolated on Earth in 1895.

Since helium is an inert gas and not toxic, a mixture of 80 percent helium and 20 percent oxygen is used in a deep-sea diver's breathing tank. When ordinary air is used alone, the diver's body uses the oxygen in the air, but nitrogen builds up, forming nitrogen gas bubbles in the blood (causing a sickness known as the bends). Because helium is less soluble in the human bloodstream than nitrogen is, a helium and oxygen breathing mixture helps prevent the bends.

Apart from its use in balloons, helium is used in industry to help grow crystals of silicon and germanium, and to produce titanium and zirconium. It is a cooling medium for nuclear reactors, and it is used as a gas for supersonic wind tunnels. Helium is a relatively rare and expensive natural resource. Its principal source is natural gas wells, where it is extracted from the crude natural gas stream and purified. This is stored and shipped as either a gas or a cryogenic liquid. Many deposits will be used up early this century.

A British man reached a height of

11,000 feet (3,352 m)

strapped to 600 helium balloons

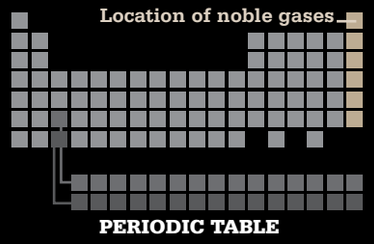
stay up

to 14 days,
onditions.
00 feet

Duration
14+ days
8–11 days
24–36 hours
12–18 hours
2 hours

Collect more noble gases

Noble gases [The bright team]



Five of the noble gases—helium, neon, argon, krypton, and xenon—are often seen as bright lights. Neon and argon are the two main gases used in illuminated signs. You can usually tell them apart by the color of the light: Neon is very bright and gives off a red glow, while argon emits a weaker light but can be yellow, blue, green, or purple. They can be mixed with other gases to create other shades. Krypton, on the other hand, does an important invisible job—it is used to detect gas leaks. Radon, the sixth noble gas, is used mainly in scientific equipment.

Periodic table complete collection

10 Ne Neon

Glowing light
Whenever you see a glowing red sign you are probably looking at neon. Neon advertising signs are glass tubes filled with neon gas with an electrical current running through them.

AMAZING ELEMENTS

Predicting earthquakes 86 Rn
Scientists monitor radon levels in groundwater in an effort to predict earthquakes, since radon emissions increase just before an earthquake. Look up more earthquake facts to add to your collection!

18 Ar Argon

Car lightbulb
Bluish argon headlights, called High Intensity Discharge (HID) lamps, are brighter than the usual halogen bulbs.

18 Ar Argon

Prepackaged food
Scientists have found that using argon to fill space inside plastic packs keeps salads and chips fresher.

54 Xe Xenon

Plasma TV
Xenon (and neon) gas is used in a plasma TV, contained in thousands of tiny cells positioned between two plates of glass.

10 Ne Neon

Clock face
Numbers and hands on clock faces that light up in the dark are usually filled with neon or argon gas.

36 Kr Krypton

Krypton flashlight
Krypton-bulb flashlights cast a light that is usually warmer, or more yellow in color, than that of LED flashlights.

54 Xe Xenon

Film projector
Xenon bulbs are the most commonly used lamps in electrical products. For example, they are used with mirrors to reflect light onto film.

Helium [Noble gases]

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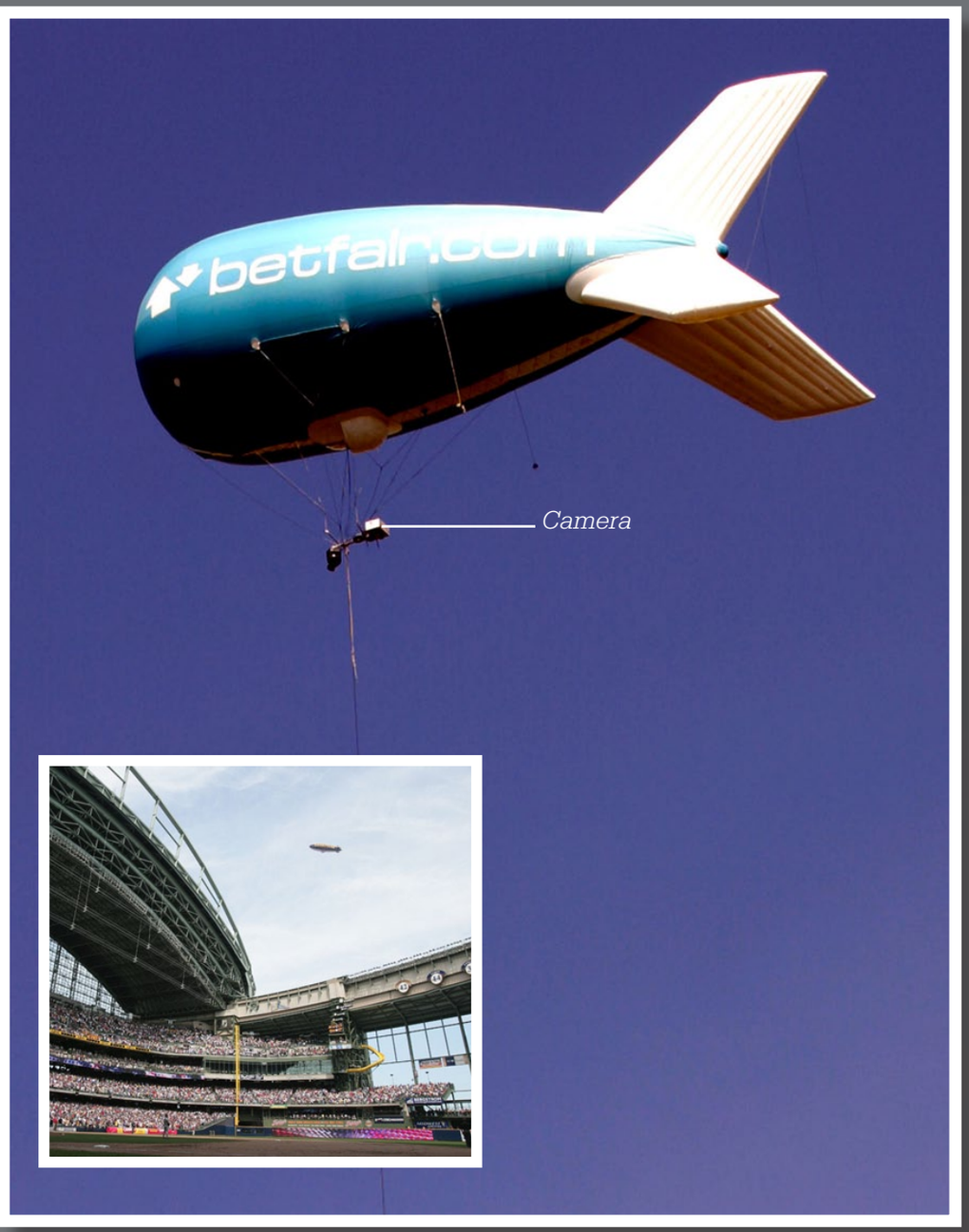

Blimps and airships

Blimps and airships are types of lightweight aircraft with power and steering systems that use a lighter-than-air gas, usually helium, to lift the craft like balloons. Helium is heavier than hydrogen, which was first used to float airships. But hydrogen is flammable (bursts into flames easily), and after an airship exploded with passengers on board in 1937 (the *Hindenburg*), other gases were investigated. The first airships were developed in France in the 1880s and called dirigibles ("steerables"), because they could be steered and could also be flown against the wind.

There are two main types of airship: the rigid airship, which has a frame inside, and the nonrigid blimp, which has no internal frame and loses its shape once the gas is let out. Blimps have become popular in the last few decades. Among new types are small blimps, some remote controlled, that are tethered inside stadiums and used to provide television audiences with bird's-eye views of sports events. Small blimps display advertising logos painted on their sides, and others are once again used to carry passengers, usually groups of tourists, in gentle slow motion over scenic areas such as the California coast.

The *Hindenburg* measured

803.8 feet (245 m)

long—the largest airship ever

How long helium balloons stay up

Duration
14+ days
8–11 days
24–36 hours
12–18 hours
2 hours

Collect more noble gases

Helium [Noble gases]

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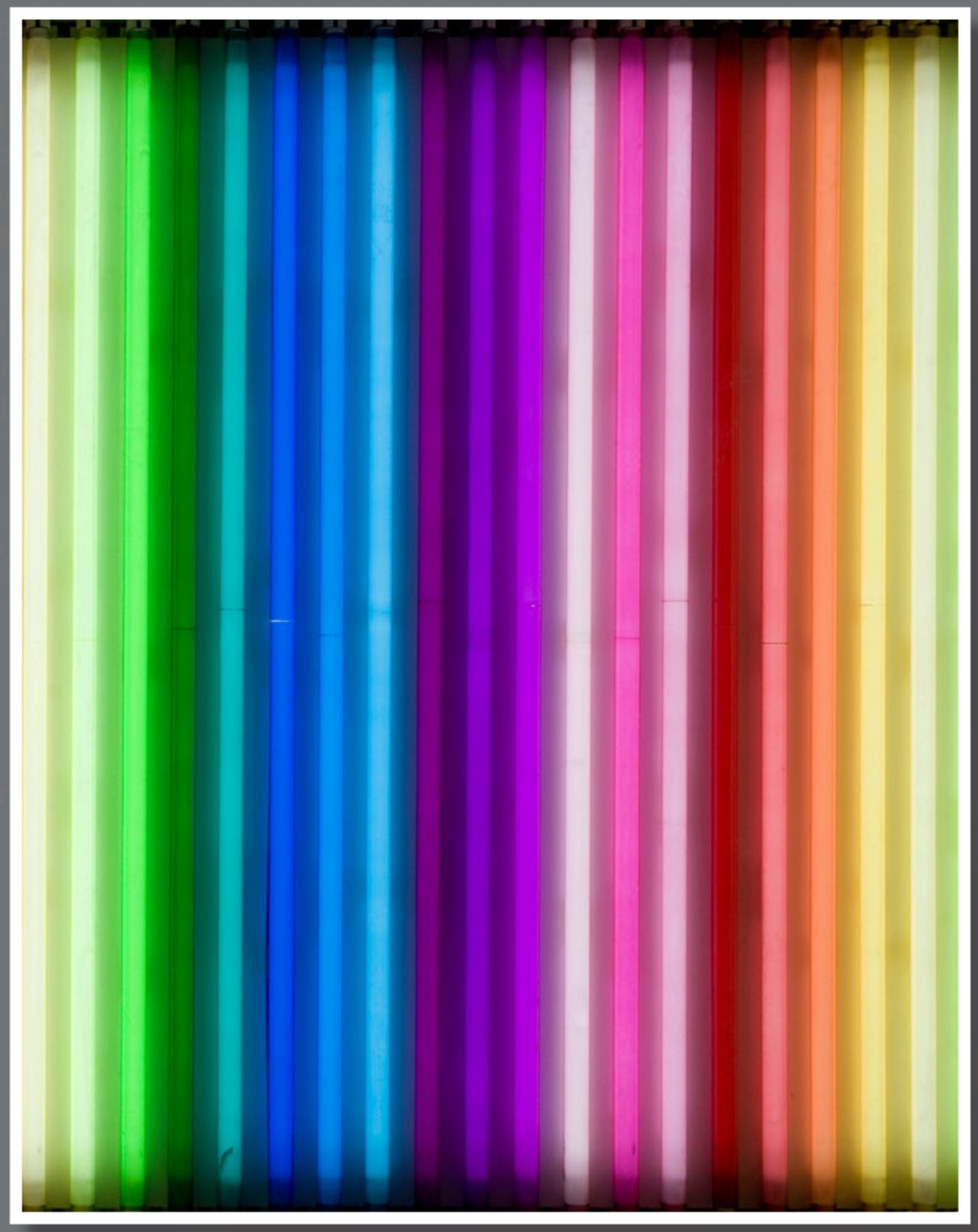

Inert gas

The inert gases, or noble gases, are unique not because of the properties they possess, but because of the properties they lack. They lack odor. They lack color. They lack taste. They cannot be detected at all without special equipment. Most important, these six elements resist combining with other elements.

The noble gases are helium, neon, argon, krypton, xenon, and radon. The terms *inert* and *noble* are derived from the extreme resistance of these gases to combining chemically with other elements. Xenon has been found to combine with other elements to form compounds, but generally the noble gases tend to remain apart.

Chemical stability exists because the outermost shell of each noble gas atom is full, filled with eight electrons (octet), except for helium, which has two. Most other chemical elements have to react with one another in order to achieve this stable octet electron configuration—either by losing electrons to their reacting partners or by gaining electrons from them. This is called ionic bonding. Some of the most common bonds between elements occur when the elements share their electrons rather than losing or gaining them. This sharing is called covalent bonding.

| **Latex** (from rubber trees) is

stay up

to 14 days,
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Duration
14+ days
8–11 days
24–36 hours
12–18 hours
2 hours

Collect more noble gases

Helium [Noble gases]

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Cryogenics

Cryogenics is the study of the properties of matter at incredibly low temperatures. The name comes from the Greek *kryos*, meaning "icy cold." The highest temperature dealt with by cryogenics is about –148°F (–100°C), and the lowest is the absolute zero temperature of –459.67°F (–273.15°C). In cryogenics, temperatures in the lowest range use the Kelvin scale, with absolute zero at 0 K. (Kelvin and Rankine are known as absolute temperature scales, as opposed to the relative temperature scales of Fahrenheit and Celsius.)

All gases, when cooled enough, condense into liquids and even freeze. When helium is cooled below 2.2 K, it develops strange properties. It becomes a superfluid, with the ability to flow uphill and at different speeds in different directions.

Liquid helium is widely used in cryogenic research to enable scientists to experiment with materials. It had been known for many years that the electrical resistance of metals decreases with falling temperatures, eventually making them superconductors—that is, they lose all their electrical resistance. The results are used in equipment for the nuclear industry, in scanning machinery for hospitals, and in computer memories and communication devices.

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Helium [Noble gases]

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		Duration
2 Foil	1.5 ft. (0.5 m)	8–11 days
3 Latex/rubber	16 in. (40.5 cm)	24–36 hours
4 Latex/rubber	11 in. (27.5 cm)	12–18 hours
5 Weather balloon	5 ft. (1.7 m)	2 hours

electrical resistance *noun*

Electrical resistance is the degree to which an object can obstruct the flow of an electric current, either partially or wholly.

The resistance of a metal usually increases as it gets hotter. At very low temperatures, the resistance of some materials falls to zero.

A resistor is a component of an electrical circuit that resists the flow of electrical current.

Collect more noble gases

Helium [Noble gases]

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Helium is the first member of the group of **inert gases**

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temperature *noun*

Temperature is the relative hotness or coldness of an object, as measured on a standard scale.

The temperature of an object or of a system is a measure of the tendency of heat to flow into or out of the object or system in its given environment.

stay up

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		Duration
		14+ days
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Collect more noble gases

Lanthanum [Lanthanoids]

HOME

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Rare earth metals (the 15 lanthanoids plus yttrium and scandium) have become increasingly important since the rise of the electronics industry. Many of the high-tech things you use every day rely on alloys containing them, from cell phones, computers, and rechargeable batteries, to car components. They are also used in commercial lighting—in streets, stadiums, and film sets—and in powerful magnets used in medical and industrial equipment. Rare earth magnets are small, lightweight, and have a high magnetic strength.

Rare earth metals are not as rare as their name implies. Lanthanum and most of the other lanthanoids are abundant in the earth, but because they have similar properties, they are often found together, making them difficult to separate and use.

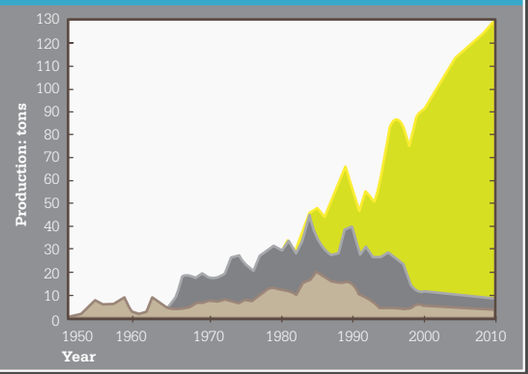
Alloys of lanthanum (and other rare earth metals) are used to make ultrastrong magnets used in electronic devices, and they also find their way into many magnets stuck on fridge doors.

Most fridge magnets are known as ceramic or ferric magnets, because they contain iron oxide mixed in with a ceramic material such as clay. Adding rare earth metals increases their strength.

China extracts almost **97%** of the world's supply of rare earth metals

Global production of rare earth metals

Rare earth metals are mixed in rock in small amounts all over the world, but they are hard or costly to extract, so most of the supply of rare earth **oxides** used in manufacturing now comes from a few sources. The graph shows how the market has changed from discovery to 2010.



More lanthanum things to collect

Periodic table complete collection

Collect more lanthanoids

Lanthanum [Lanthanoids]

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Rare earth metals (the 15 lanthanoids plus yttrium and scandium) have become

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Lanthanum

Lanthanum is silvery white in color, and it is so soft that it can be cut with a knife. It is also ductile, which means that it can be drawn into a wire if hammered, and malleable, which means that it can be given any form by hammering or by applying pressure. Lanthanum produces sparks when rubbed, so it is used in misch metal, a type of alloy used as a flint in lighters.

The element was discovered in 1839 by Carl Mosander, a Swedish chemist. Its purified form was developed a century later. The word *lanthanum* comes from the Greek term *lanthanein*, which means "to lie hidden"—because it was not easy for Mosander to discover the element, since it wasn't in its pure form. In recent years, it has been available on a large scale. Lanthanum is used chiefly in the manufacture of glass, high-quality camera lenses, and high-intensity lights for the movie industry.

Lanthanum is one of the 15 lanthanoids in the periodic table. The lanthanoids are found in many minerals, principally monazite, a heavy, dark sand from which about 50 percent of the lanthanoids available to science and industry has been extracted. Cerium is the most abundant of the group. Pure lanthanoids are silvery metals with high melting points. They discolor slowly in air.

Global demand for rare earth metals has tripled to

132,000 tons

per year over the past ten years

More lanthanum things to collect

Many people believe that we should not rely on oil and gas for fuel, since these resources aren't replaced naturally. There is a growing demand for green energy (power sources that are created and used in a way that conserves natural resources and the environment). Modern environmentally friendly inventions such as **hybrid cars**, rechargeable batteries, wind turbines, and energy-efficient lightbulbs use lanthanum and other lanthanoids.

Collect more lanthanoids

Periodic table complete collection

AMAZING ELEMENTS

Military uses
The military uses lanthanoids in high-tech applications such as lasers, radar, missile guidance systems, satellites, and night-vision goggles.

57
La

Desk lamp

Lanthanum compounds are used with carbon to create bright white lights.

Hybrid car

A modern hybrid car needs many compounds and alloys of lanthanoids. Lanthanum is used in the battery and the converter and is added to diesel fuel; neodymium magnets are used in the motors; cerium is used in the windshield, mirrors, and LCD screen inside; yttrium is used in the sensors. Do you know someone with a hybrid car? Go take a look.

Energy-efficient lightbulb

A low-energy lightbulb includes lanthanum compounds in the light-producing coating on the inside surface of the bulb.

TV screen

Lanthanum compounds are used in screens as phosphors (light-producing materials) that emit colored light.

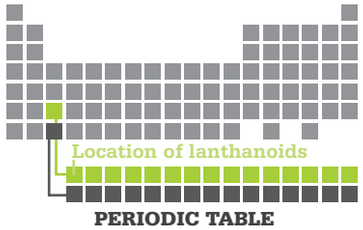
Video camera lens

High-quality lenses used in cameras and video cameras are often made of glass that contains a small quantity of pure lanthanum oxide.

Outdoor pool

Lanthanum compounds help prevent algae growth in some outside pools.

Lanthanoids [The modern team]



Pure lanthanoids are silvery metals with high melting points. They were considered geological oddities when they were discovered; now their uses range from adding color to glass (to enhance picture brightness in television and computer monitors) to making strong permanent magnets in industry. A neodymium magnet weighing a fraction of an ounce (a few grams) can lift something a thousand times its own weight.

Collect even more lanthanoids

Periodic table complete collection

63 Eu **Europium**

Euro (European Union money)
Europium causes **luminescence** in euro banknotes, used to prevent the money from being illegally copied.

64 Gd **Gadolinium**

USB flash drive
Gadolinium compounds are used to manufacture computer memory chips and CDs.

59 Pr **Praseodymium**

Glass bead
As a pigment in earth, praseodymium is usually a gorgeous green. It has been used to stain enamel and decorative glass, including beads, since the 1920s.

70 Yb **Ytterbium**

Portable X-ray machine
Ytterbium is used in portable X-ray machines. You will need to collect a picture of this.

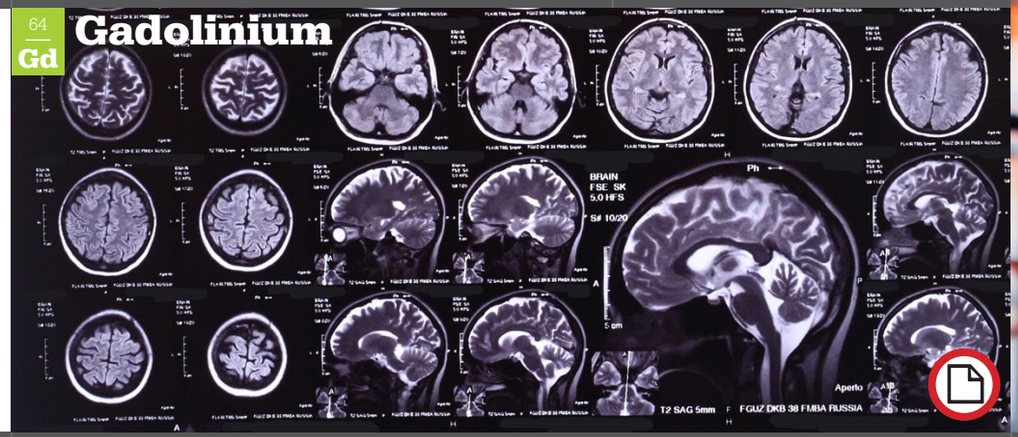
60 Nd **Neodymium**

Headphones
Neodymium magnets are the strongest in the world. They are often used to create tiny loudspeakers in headphones.

60 Nd **Neodymium**

Cell phone
Cell phones also contain tiny neodymium magnets inside their speakers to boost their power.

64 Gd **Gadolinium**



X-ray
Gadolinium, along with some of the other lanthanoids, is useful for its role in specialized imaging equipment in hospitals, such as X-ray and magnetic resonance imaging (MRI) machines. Add a picture of an X-ray to your collection.

59 Pr **Praseodymium**

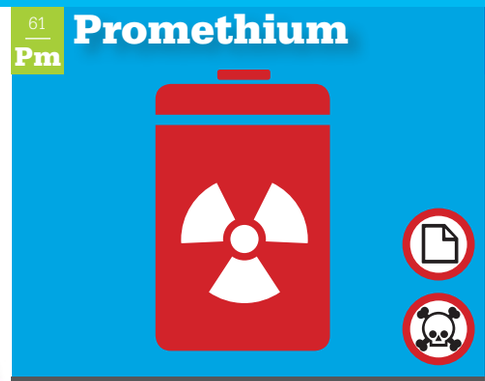
Sunglasses
The glass in welders' goggles contains a mixture of praseodymium and neodymium. It is also used in sunglasses, because it can block ultraviolet light.

More lanthanoids

68 Er Erbium

Pink ceramics
This silvery-white metal helps create photographic filters and is a pink coloring agent in some sunglasses and ceramics.

61 Pm Promethium

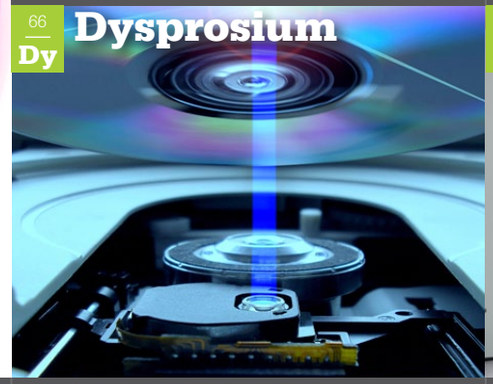


Atomic battery
Promethium is used in atomic batteries and in space exploration, providing heat and power sources for satellites.

65 Tb Terbium

Fluorescent lamp
Terbium oxide is in fluorescent lamps and television tubes; it is also used in naval sonar systems.

66 Dy Dysprosium



Compact disc
Dysprosium is part of a magnetic alloy in some CDs, DVDs, and other data storage devices.

71 Lu Lutetium

PET scanner
Lutetium is used in positron emission tomography (PET) scanners, which create 3-D images of the body's cells.

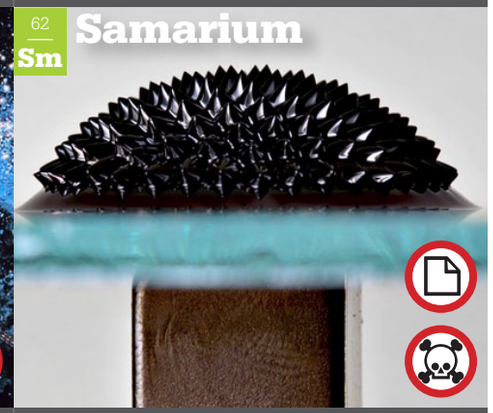
67 Ho Holmium

Nuclear reactor
Holmium has a greater magnetic strength than any other element. Holmium absorbs neutrons in nuclear reactor control rods. Find some facts for your collection.

69 Tm Thulium

Satellite
Lasers containing thulium are used in satellites that take pictures of the Earth and also in surgical tools. Find images of a satellite or the photos it takes.

62 Sm Samarium



Rare earth magnet
Rare earth magnets are strong but brittle (prone to chipping) and made from alloys of samarium or neodymium. Add an image of one to your collection.

Periodic table complete collection

58 Ce Cerium

Yellow ceramics
Cerium is one of the most abundant rare earth elements. Although it is a gray metal, it is used to create a yellow coloring in decorative glass and ceramics. It is also added to diesel fuel to help it burn better.

More lanthanum things to collect

Many people believe that we should not rely on oil and gas for fuel, s… these resources aren't replaced naturally. There is a grow… create… the en… such a… energy…

Hybrid car

Although all cars have batteries—to start the car and run the radio, headlights, and other accessories—it is usually gas that provides the fuel for them to move. A hybrid car, however, uses two forms of energy. It usually does have a conventional gasoline (or sometimes diesel) engine, but it also has a bank of batteries that powers an electric motor. Power is shared between both sources, so a hybrid is like a cross between a conventional car and an electric car. Unlike in electric cars, which need to be charged regularly, the engine in a hybrid car can put energy into the batteries as well as taking energy from them, charging them up as the car drives along.

Development of hybrid cars started in the 1990s, in an attempt to increase the number of miles a car could travel before having to be refueled, and to reduce the pollution emitted by gas-powered cars.

A hybrid electric car contains over

20 lb. (9.09 kg)

of lanthanum in its battery pack

A low-energy lightbulb includes lanthanum compounds in the light-producing coating on the inside surface of the bulb.

Lanthanum compounds are used in screens as phosphors (light-producing materials) that emit colored light.

High-quality lenses used in cameras and video cameras are often made of glass that contains a small quantity of pure lanthanum oxide.

Lanthanum compounds help prevent algae growth in some outside pools.

Lanthanum [Lanthanoids]

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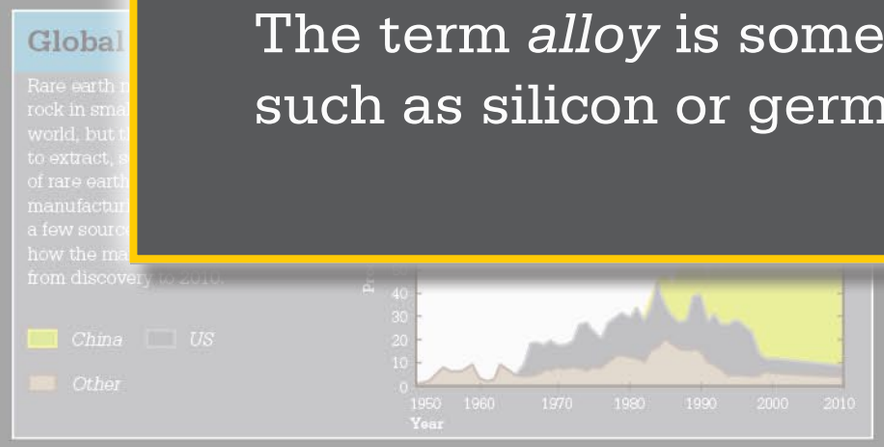

alloy *noun*

An alloy is a mixture of metals that may also include other chemical elements. Some well-known alloys are brass (copper and zinc), bronze (copper and tin), and steel (iron and carbon). Alloys consisting of metals and metalloids such as antimony, or of metals and nonmetals such as silicon, have many uses in industry.

Alloys are divided into two broad groups: ferrous alloys, with iron as the primary metal, and nonferrous alloys, with a metal other than iron. The term *alloy* is sometimes also used for a mixture of semiconductors such as silicon or germanium.

More lanthanum things to collect

Periodic table complete collection

Collect more lanthanoids

More lanthanoids

68 Er **Erbium**

61 Pm **Promethium**

65 Tb **Terbium**

Periodic table complete collection

laser *noun*

A laser is a device that produces bright, focused light of a single color. Both ordinary light and laser light are forms of energy called electromagnetic radiation. Laser light occurs when a group of similar atoms exists in an excited state. The atoms' high-energy electrons continually emit photons (tiny particles of light). These photons then collide with the electrons and cause them to emit more photons, in the form of a beam of light. The word *laser* comes from the phrase *Light Amplification by Stimulated Emission of Radiation*.

Surgeons use beams of laser light to correct vision defects. Geologists use laser instruments to predict earthquakes. And astronomers use laser-aided telescopes to see distant stars more clearly.

Pink ceramics
This silvery-whit
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67 Ho **Holmi**

Nuclear reactor
Holmium has a greater magnetic strength than any other element. Holmium absorbs neutrons in nuclear reactor control rods. Find some facts for your collection.

Satellite
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Pure lanthanoids are silvery metals with high melting points. They were

59 Praseodymium

luminescence *noun*

Luminescence is the emission of light by a mineral, not caused by being heated, or the light so produced. The numbers on a watch that glows in the dark are luminous. Some animals have natural light-producing properties called bioluminescence, such as fireflies, glowworms, and many varieties of marine life, including deep-sea fish.

The color of the emitted light is not related to the color of the mineral in white light, and it is usually so faint that it can be seen well only in the dark. Some minerals never luminesce—only minerals that contain impurity ions called activators produce luminescence.

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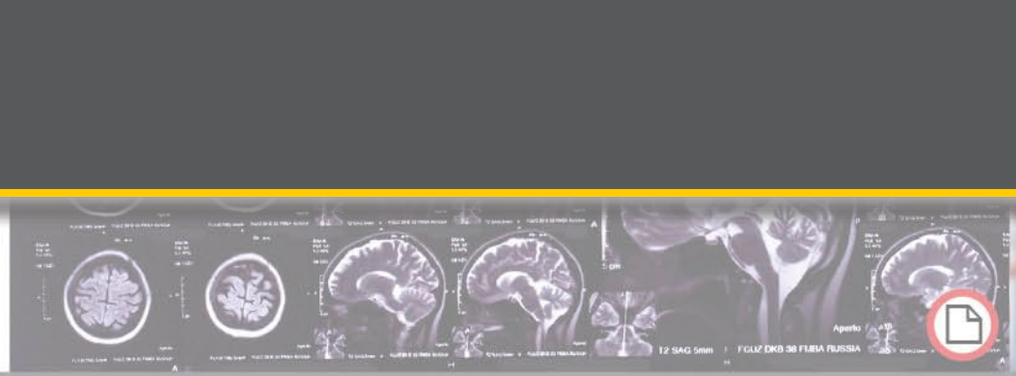
60 Nd Neody

Headphones
Neodymium magnets are the strongest in the world. They are often used to create tiny loudspeakers in headphones.

Cell phone
Cell phones also contain tiny neodymium magnets inside their speakers to boost their power.



X-ray
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Sunglasses
The glass in welders' goggles contains a mixture of praseodymium and neodymium. It is also used in sunglasses, because it can block ultraviolet light.

Lanthanum [Lanthanoids]

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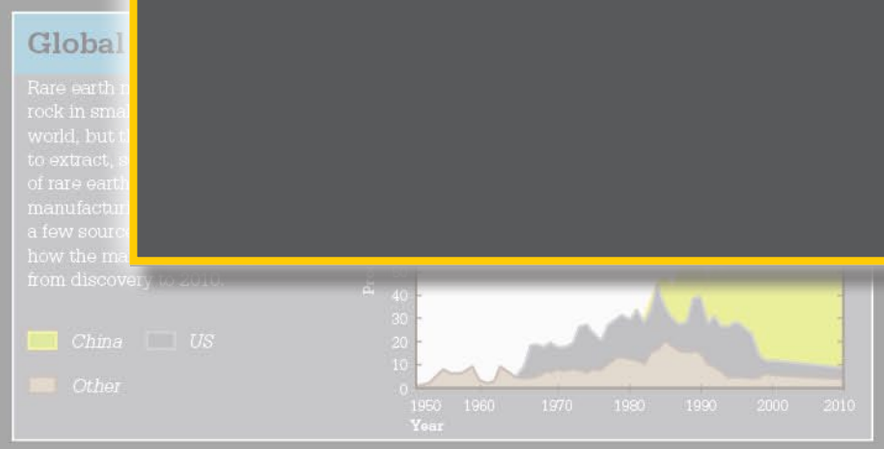
oxide *noun*

Simple oxides consist of metal atoms combined with oxygen atoms. The metals react with oxygen in the air to produce metal oxides, like magnesium oxide. These compounds are solids at room temperature and have high melting points.

Nonmetals also react with oxygen in the air to produce nonmetal oxides; for instance, carbon and oxygen form carbon dioxide.



More lanthanum things to collect

Periodic table complete collection

Collect more lanthanoids

Thorium [Actinoids]

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Thorium is a soft, silvery-colored metal that is very ductile, or capable of being stretched into a wire without snapping. Like the other actinoids, thorium is radioactive. Alloys of thorium and magnesium are used in engine parts for aircraft and rockets because of their light weight and their strength at high temperatures. Thorium fluoride (a compound of thorium and fluorine) is used to make glass for optical lenses, like those in telescopes. Thorium oxides (compounds with oxygen) are used in ceramics, medicines, and photocells that create energy from sunlight.

Thorium is increasingly important in the creation of nuclear fuels. Although uranium and plutonium dioxides are currently most commonly used in nuclear reactors to create electricity, many energy experts recommend a switch to thorium because it is plentiful and generates less harmful waste.

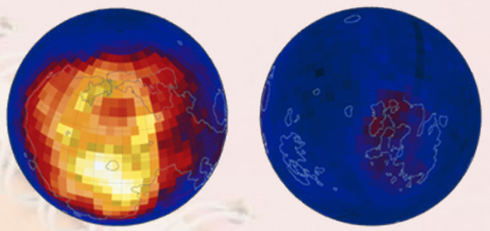
The calculator's display and electronics are powered by photocells containing thorium oxides.

The miniature solar panel on this calculator includes a photoelectric cell. Compounds of thorium inside the cell produce an electric current if light shines on them.

More thorium things to collect

Thorium on the Moon

NASA'S Lunar Prospector mission, launched in 1998, has revealed that thorium is abundant on the Moon. Maps created with data from the mission show that the radioactive element is concentrated in a region on the Moon's nearside (left), but there is another small area of thorium on the side of the Moon that faces away from Earth.



Thorium on nearside *Thorium on farside*

Periodic table complete collection

Collect more actinoids

Thorium [Actinoids]

Solar garden light with photoelectric cell

Thorium

Thorium is a naturally occurring radioactive metal. It was discovered in 1828 by the Swedish chemist Jöns Jacob Berzelius, who named it after Thor, the Norse god of thunder. It is found in small amounts in most rocks and soils, where it is about three times more abundant than uranium. Soil generally contains an average of 6–12 parts of thorium per million. Uranium and thorium are thought to be the primary sources of Earth's internal heat. The planet is warmed by their radioactive decay. Although thorium is radioactive, its atoms decay over such a long period of time (billions of years) that the radioactivity does not pose a problem.

Thorium is found in a number of minerals, including monazite and thorite, but it is extracted mainly from monazite for commercial purposes. It is used to make strong, light alloys found in some photoelectric cells, which are used to create solar power. It is also a common ingredient in high-quality lenses and ceramics.

The most important potential use for thorium is as a replacement for uranium in creating nuclear power. Thorium may eventually become a major source of nuclear energy. Nuclear experiments in the 1950s made use of both thorium and uranium, and uranium was decided to be the better choice at the time. Now, though, the first major nuclear-energy plant using thorium is being built in India, where some of the world's largest thorium deposits are located.

The world total of thorium could be as much as

2,877,000 tons

More thorium things to collect

The earliest use of thorium was in gas streetlamps in the late 1800s, called Welsbach mantles after their Austrian inventor, Carl Auer von Welsbach. These contain fabric coated with thorium dioxide (thorium with carbon and oxygen) and other chemicals that, when heated, give off a bright light. Welsbach mantles are still used in some portable lamps for camping and in outdoor lighting. Thorium oxide coats tungsten wire in lighting for electronic equipment, and it is also used in glass and bright searchlights.

Periodic table complete collection

Collect more actinoids

AMAZING ELEMENTS

Searchlight

The bright beams of light given off by searchlights are made even brighter by thorium fluoride (a compound of thorium and fluorine). Thorium is also used in film lighting.

90 Th

Intruder alarm

Some home intruder alarms have sensors containing thorium compounds.

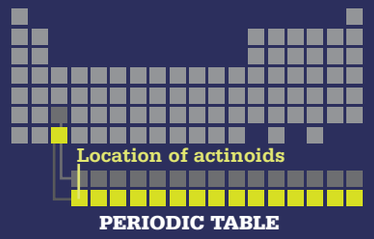
Telescopic lens

Thorium fluoride is used as an antireflective coating material in telescopic lenses, binoculars, and scientific instruments.

Camping lamp

If your family goes camping regularly, you may have a portable thorium mantle lamp. LED lights that use batteries are more common now, but mantle lamps are still available.

Actinoids [Radioactive]

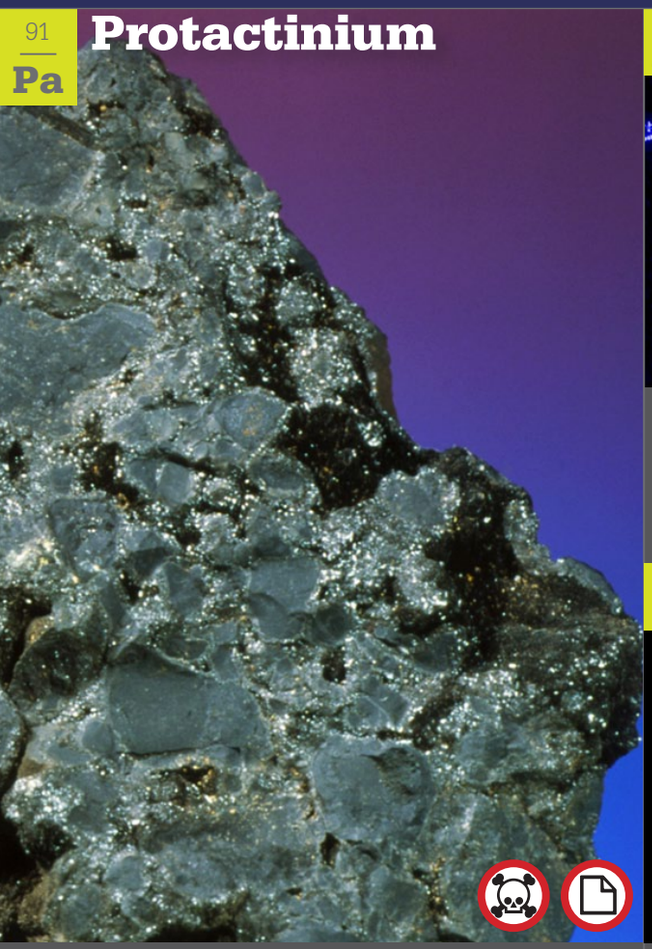


The first four members of the actinoids—actinium, thorium, protactinium, and uranium—occur naturally, but the transuranium elements (with atomic numbers higher than uranium's) are all produced artificially. All the elements in the actinoid series, except uranium and thorium, are so radioactive that special precautions are needed when handling them, and most are used only in experiments. You will need to collect pictures and facts for these elements. Some of them are so unstable that they can't even be photographed!

Periodic table complete collection

94 Pu **Plutonium**

Nuclear-power station
Over one-third of the energy produced in most nuclear-power plants comes from plutonium, a metal created from uranium in a nuclear reactor. Add a photo to your collection.



91 Pa **Protactinium**

Uraninite
Protactinium is a very rare metal that is present in a uranium-containing ore (rock) called uraninite. It was first isolated from uranium by British chemist William Crookes in 1900. Protactinium is used mainly in scientific research.

89 Ac **Actinium**

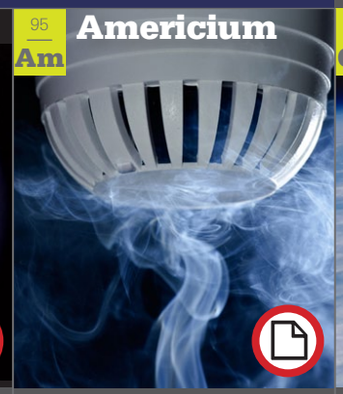
Actinium
Actinium is a silvery metal that is so radioactive, it glows blue in the dark as it reacts with the air.

92 U **Uranium**

Seawater
Collect some seawater! There is estimated to be three times more uranium in the sea than in the earth.

93 Np **Neptunium**

Neptune
Named after the planet Neptune, neptunium is a rarely found metal that is produced from uranium.



95 Am **Americium**

Smoke detector
Just 0.04 ounces (1 g) of americium oxide can be used in more than 3 million household smoke detectors.

96 Cm **Curium**

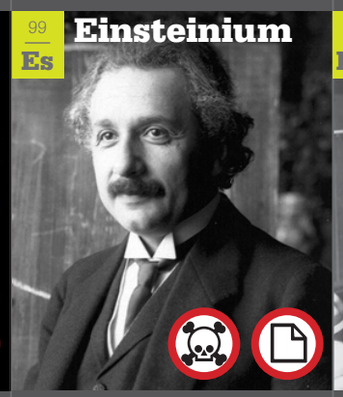
Space probe
Curium is produced from plutonium in small amounts and is used in generators that power spacecraft.

97 Bk **Berkelium**

University of California
Discovered in Berkeley, California, in 1949, this metal is produced from americium in small amounts.

98 Cf **Californium**

Luggage screening
Californium **isotopes** are used in airport screening equipment that checks luggage for explosives.



99 Es **Einsteinium**

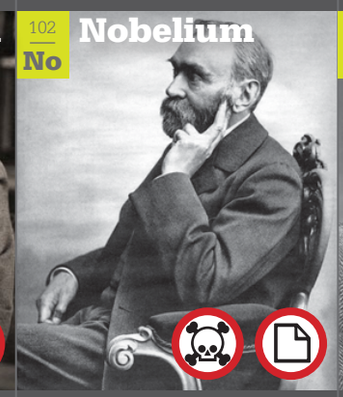
Albert Einstein
This metal, discovered in 1952, is named after one of the best-known scientists, Albert Einstein.

100 Fm **Fermium**

Enrico Fermi
Fermium was found in 1952. The name recognizes Italian Enrico Fermi, one of the pioneers of nuclear physics.

101 Md **Mendelevium**

Dmitri Mendeleev
Mendelevium is produced from einsteinium and honors the chemist Mendeleev, who classified the elements.



102 No **Nobelium**

Alfred Nobel
Isolated from curium in 1957, nobelium is named in honor of scientist and Nobel Prize founder Alfred Nobel.

103 Lr **Lawrencium**

Albert Ghiorso
Ghiorso was one of four scientists who discovered lawrencium in 1961 at the Lawrence Berkeley Lab, US.

Thorium [Actinoids]

Thorium is a soft, silvery-colored metal that is very ductile, or

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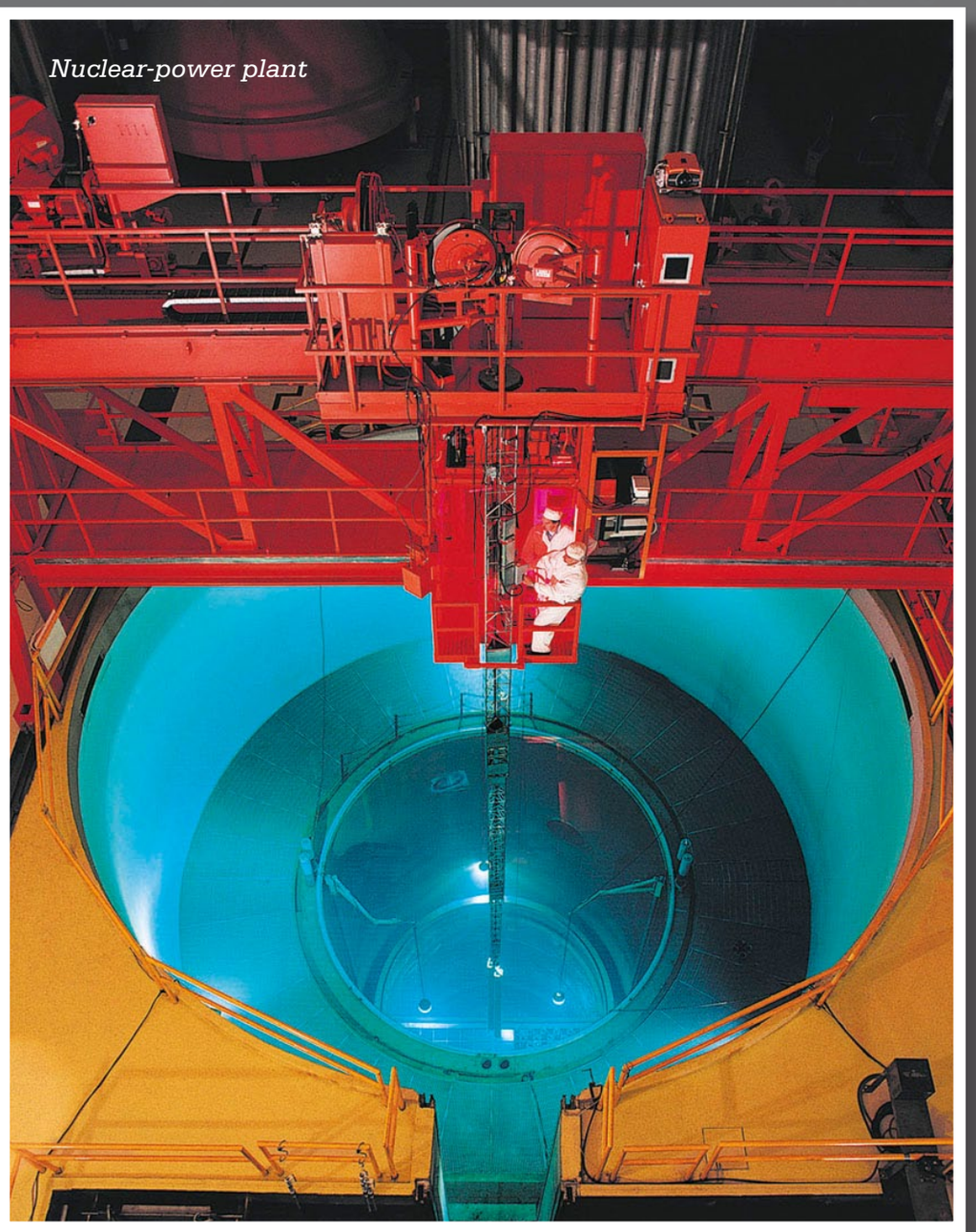

Nuclear-power plant

Nuclear reactor

A nuclear reactor is a device in which a controlled nuclear reaction takes place. This reaction is nuclear fission. Nuclear fission involves the splitting of nuclei—the very small cores at the centers of atoms. When this happens, a tiny amount of mass is destroyed, releasing energy. Nuclear power is derived from the energy released. Nuclear reactors are most commonly used to produce electric energy. The main nuclear fuel currently used is uranium, but thorium is also becoming popular.

Nuclear fuels are not burned to release energy. Instead, the fuels are used in nuclear reactions, which release heat. The rest of the process of generating electricity is then identical to the process using fossil fuels (such as coal and gas). Nuclear reactors are used in submarines to provide power that lasts around 100,000 miles (160,000 km).

Many scientists believe that a switch from uranium to thorium as the main nuclear fuel would be beneficial to the planet. Thorium is far more abundant than uranium, it creates electricity more cleanly, and the waste products it generates are less dangerous and virtually impossible to turn into plutonium, so it would be less likely to contribute to the creation of nuclear weapons.

1 ton of thorium could power more than

1,000,000

homes with electricity for a whole year

Thori

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Collect more actinoids

Thorium [Actinoids]

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Thoriu
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nucle
switch

The calculator's display | | The miniature solar panel

isotope *noun*

Isotopes are atoms of the same element that have the same number of protons and electrons but a different number of neutrons in their nuclei (centers). Isotopes can be synthetic (artificially created in a laboratory) or natural.

Each isotope of an element will have the same atomic number (number of protons). For instance, hydrogen has three naturally occurring isotopes, sometimes written ^{1}H, ^{2}H, and ^{3}H. The most common isotope of hydrogen, ^{1}H, has no neutrons at all. ^{2}H is a hydrogen isotope with one neutron, and ^{3}H has two neutrons. All three hydrogen isotopes contain one proton each.

Thori

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nearside (
area of thorium on the side of the Moon
that faces away from Earth.

Thorium on nearside *Thorium on farside*

Periodic table complete collection

Collect more actinoids

90
Th

radioactive *adjective*

Radioactive elements give off radiation from their nuclei (the centers of their atoms) when the nuclei are rearranging themselves. Three main types of radiation are emitted from radioactive atoms: alpha, beta, and gamma radiation. Alpha and beta radiation are given off in the form of particles when a radioactive nucleus is in the process of changing into a different nucleus—either of a different element or of a different isotope of the same element.

During this change, the nucleus also emits energy in the form of gamma rays, which are similar to X-rays. Gamma radiation can be harnessed to kill bacteria in food, to destroy cancer cells, or to produce electricity. However, the radiation can also be harmful.

The calculator's display | | The miniature solar panel

Thorium on nearside | Thorium on farside

Periodic table complete collection

HOME

Start creating your own 3-D periodic table. Look around to find examples of something made from each element, or take photos. Look in the book *The Elements* (pages 22–23) and in this digital book to find out more about how the table is organized, and to discover more about every group and every element.

Scientists are working on identifying element

120

GROUPS (VERTICAL COLUMNS)

PERIODS (HORIZONTAL ROWS)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H HYDROGEN																	2 He HELIUM
2	3 Li LITHIUM	4 Be BERYLLIUM											5 B BORON	6 C CARBON	7 N NITROGEN	8 O OXYGEN	9 F FLUORINE	10 Ne NEON
3	11 Na SODIUM	12 Mg MAGNESIUM											13 Al ALUMINUM	14 Si SILICON	15 P PHOSPHORUS	16 S SULFUR	17 Cl CHLORINE	18 Ar ARGON
4	19 K POTASSIUM	20 Ca CALCIUM	21 Sc SCANDIUM	22 Ti TITANIUM	23 V VANADIUM	24 Cr CHROMIUM	25 Mn MANGANESE	26 Fe IRON	27 Co COBALT	28 Ni NICKEL	29 Cu COPPER	30 Zn ZINC	31 Ga GALLIUM	32 Ge GERMANIUM	33 As ARSENIC	34 Se SELENIUM	35 Br BROMINE	36 Kr KRYPTON
5	37 Rb RUBIDIUM	38 Sr STRONTIUM	39 Y YTTRIUM	40 Zr ZIRCONIUM	41 Nb NIOBIUM	42 Mo MOLYBDENUM	43 Tc TECHNETIUM	44 Ru RUTHENIUM	45 Rh RHODIUM	46 Pd PALLADIUM	47 Ag SILVER	48 Cd CADMIUM	49 In INDIUM	50 Sn TIN	51 Sb ANTIMONY	52 Te TELLURIUM	53 I IODINE	54 Xe XENON
6	55 Cs CESIUM	56 Ba BARIUM	57–71 La-Lu LANTHANOIDS	72 Hf HAFNIUM	73 Ta TANTALUM	74 W TUNGSTEN	75 Re RHENIUM	76 Os OSMIUM	77 Ir IRIDIUM	78 Pt PLATINUM	79 Au GOLD	80 Hg MERCURY	81 Tl THALLIUM	82 Pb LEAD	83 Bi BISMUTH	84 Po POLONIUM	85 At ASTATINE	86 Rn RADON
7	87 Fr FRANCIUM	88 Ra RADIUM	89–103 Ac-Lr ACTINOIDS	104 Rf RUTHERFORDIUM	105 Db DUBNIUM	106 Sg SEABORGIUM	107 Bh BOHRIUM	108 Hs HASSIUM	109 Mt MEITNERIUM	110 Ds DARMSTADTIUM	111 Rg ROENTGENIUM	112 Cn COPERNICIUM		114 Uuq UNUNQUADIUM		116 Uuh UNUNHEXIUM		

More elements

Elements 113, 115, 117, and 118 are awaiting official recognition and naming.

57 La LANTHANIUM	58 Ce CERIUM	59 Pr PRASEODYMIUM	60 Nd NEODYMIUM	61 Pm PROMETHIUM	62 Sm SAMARIUM	63 Eu EUROPIUM	64 Gd GADOLINIUM	65 Tb TERBIUM	66 Dy DYSPROSIUM	67 Ho HOLMIUM	68 Er ERBIUM	69 Tm THULIUM	70 Yb YTTERBIUM	71 Lu LUTETIUM
89 Ac ACTINIUM	90 Th THORIUM	91 Pa PROTACTINIUM	92 U URANIUM	93 Np NEPTUNIUM	94 Pu PLUTONIUM	95 Am AMERICIUM	96 Cm CURIUM	97 Bk BERKELIUM	98 Cf CALIFORNIUM	99 Es EINSTEINIUM	100 Fm FERMIUM	101 Md MENDELEVIUM	102 No NOBELIUM	103 Lr LAWRENCIUM

Atomic number — 21
Symbol — Sc
Element name — SCANDIUM

Alkali metals | Alkaline earth metals | Transition metals | Poor metals | Metalloids | Nonmetals | Halogens | Noble gases | Lanthanoids | Actinoids

How to use this digital book

CREDITS

Look out for interactive buttons that light up as you roll over them. Click to discover more about amazing elements. Find out what everyday things they're in, so you can start your periodic table collection.

Look for these clickable buttons:

Periodic table

The full collection in order.

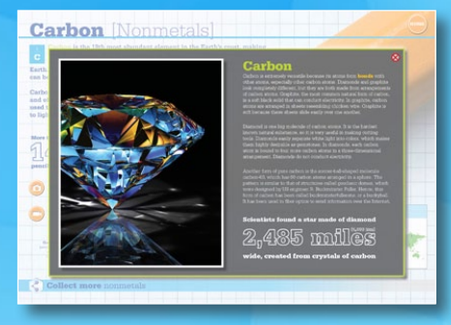
Discover more

Meet the family! Other elements in the same group.

Gallery

Lots of ideas about what to collect.

Green word



Encyclopedia entry on an element or how we use it.

Previous page

Return to home page

HOME

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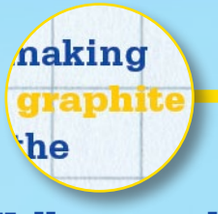
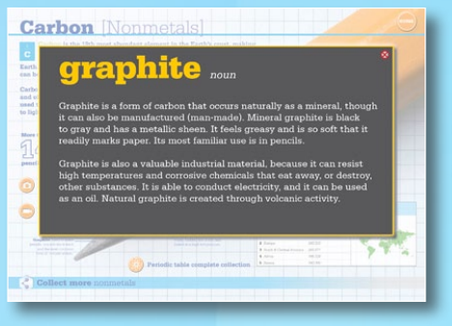
Yellow word





Glossary entry—tricky or scientific words explained.

Credits

Library of Congress Cataloging-in-Publication Data Available

ISBN 978-0-545-33019-0

First edition, January 2012

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